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Wildlife and people in the Rupununi

A comprehensive assessment based on science and local knowledge

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Wildlife and people in the Rupununi

A comprehensive assessment based on science and local knowledge

Editors
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A young boy plays with his pet red-rumped agouti early in the morning

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Foreword

Wildlife and People in the Rupununi is a collection of engaging articles on the technical and scientific work completed by the Sustainable Wildlife Management (SWM) Programme in Region 9 between 2018 and 2023. The SWM Programme is a global initiative that aims to reconcile food security with wildlife conservation concerns through sustainable and legal exploitation of resilient animal populations by Indigenous and rural populations while increasing or diversifying the supply of alternative sources of protein.

One key message in the book is the importance of involving the communities who rely on wildlife for their livelihoods in the conservation, management and sustainable use of our wildlife. This is pertinent to the work of the Guyana Wildlife Conservation and Management Commission (GWCMC) and donor-supported wildlife conservation, management, protection and sustainable use initiatives. An exemplary example is the management of river turtles in the Rupununi. This is an outstanding model for community-led management initiatives aimed at preserving river turtles whilst allowing the sustainable use of the species to continue. This inclusive and participatory approach contributes greatly to the success of the initiative.

The book contains chapters grouped in four broad areas, namely: the status of wildlife populations; local uses of wildlife; co-existence between humans and wildlife; and wildlife management and conservation initiatives in the Rupununi. Co-existence between humans and wildlife is particularly challenging, and simple solutions are elusive. The chapter on the assessment of conflict between people, livestock and carnivores adds greatly to our body of information on human–wildlife co-existence in Guyana and supports the GWCMC's work in mitigating conflict.

Wildlife is important to us all – our quality of life is dependent on healthy wildlife populations. It is critical for all Guyanese to recognize this and to take the steps necessary to secure a sustainable future for our wildlife. This interesting and valuable collection of articles will be of benefit to a wide range of stakeholders, including decision-makers; natural resource managers; regional, district and village councils; students and individual wildlife users.

"The Rupununi is a vast and untouched expanse where some of the most pristine and beautiful wildlife can be found. The work of the Sustainable Wildlife Management Programme strikes at the heart of the value that the European Union places on wildlife protection. The compilation of these articles will serve as a stark reminder in the years to come of the beauty that exists in the Rupununi. The EU is proud to finance this programme for the last five years for a total amount of EUR 4 Million and happy we have decided to extend with another three years with additional grant funding of EUR 1.8 Million."

Rene van Nes
EU Ambassador in Guyana

"As the Commissioner of the GWCMC, I find this work particularly valuable as it supports the Commission's vision to secure the future of our wildlife."

Alona Sankar
Commissioner of the Guyana Wildlife Conservation and Management Commission (GWCMC)

"This comprehensive compilation of articles brings to life the progress being made by the communities and the SWM Programme team working in the Rupununi. The book serves as an invaluable guide, offering insights and inspiration for all those pursuing a sustainable future for Guyana's wildlife."

Gillian Smith
Food and Agriculture Organization of the United Nations (FAO) representative in Guyana

"This book is a remarkable testimony to the Rupununi and the communities that manage this exceptional landscape. It is also a seminal contribution to CIFOR-ICRAF's mandate and vision."

Robert Nasi
Chief Operating Officer, Center for International Forestry Research and World Agroforestry (CIFOR-ICRAF)

Abbreviations

CI	Conservation International
CIFOR-ICRAF	Center for International Forestry Research-World Agroforestry
CIRAD	Center for International Cooperation in Agricultural Research for Development
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
EPA	Environmental Protection Agency, Guyana
FAO	Food and Agriculture Organization of the United Nations
FPIC	Free, prior and informed consent
GFC	Guyana Forestry Commission
GLDA	Guyana Livestock Development Association
GTA	Guyana Tourism Authority
GWCMC	Guyana Wildlife Conservation and Management Commission
GYD	Guyana dollar
IUCN	International Union for Conservation of Nature
KAPA	Kanashen Amerindian Protected Area
KMCRG	Kanuku Mountain Community Representative Group
LoA	Letter of Agreement
MoU	Memorandum of Understanding
NGO	Non-governmental organization
NRDDB	North Rupununi District Development Board
OACPS	Organization of the African, Caribbean and Pacific States
PAC	Protected Areas Commission
RAI	Relative Abundance Index
RDC	Regional Democratic Council
RLPA	Rupununi Livestock Producers Association
SCPDA	South Central Peoples Development Association
SRCS	South Rupununi Conservation Society
SRDC	South Rupununi District Council
SWM	Sustainable Wildlife Management
VR	Visit Rupununi
WCS	Wildlife Conservation Society
WWWC	Wapichan Wiizi Wildlife Committee
WWWMP	Wapichan Wiizi Wildlife Management Plan

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Camera trap training with SRCS at Wichabai Ranch

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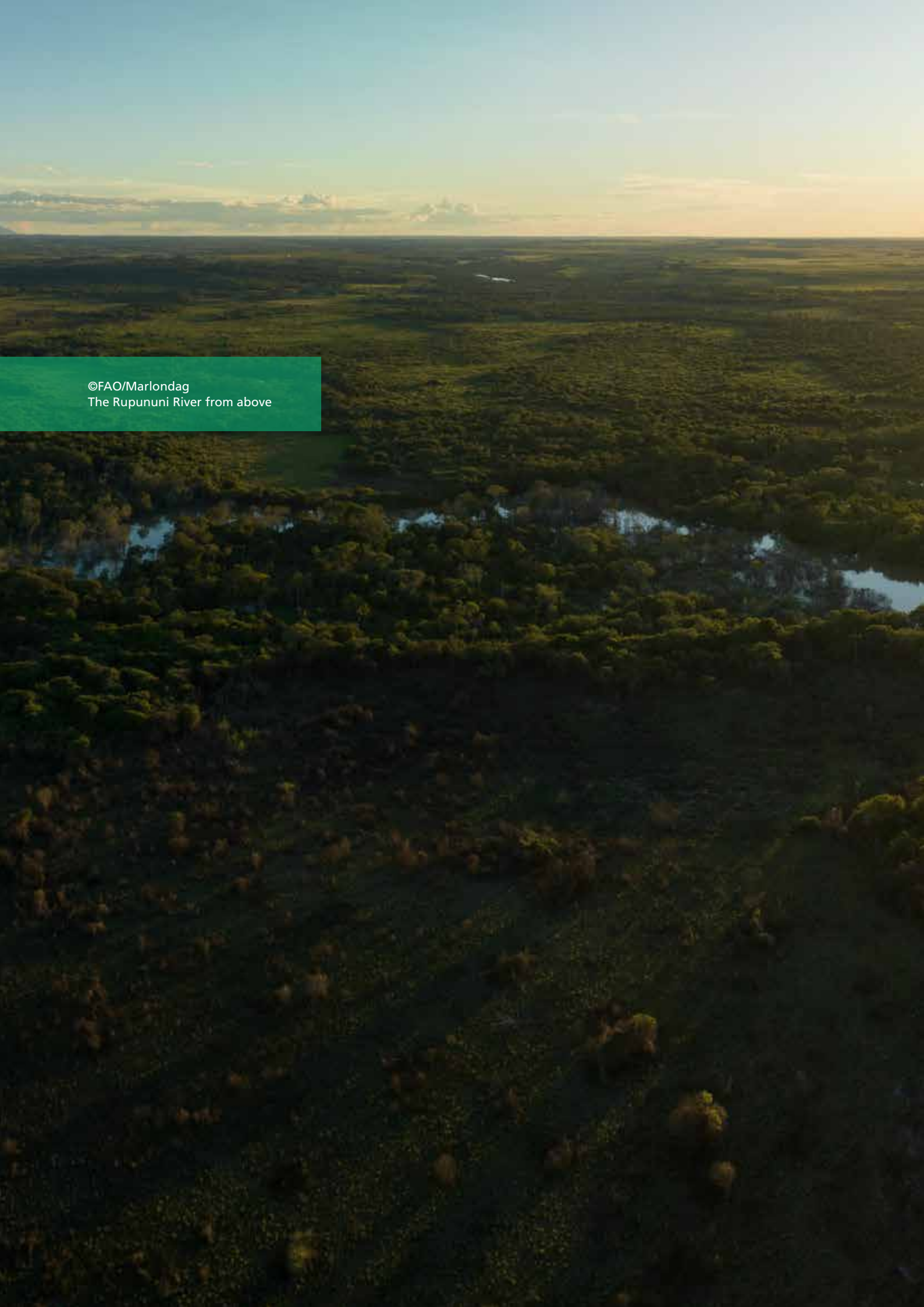
Additionally, this book received continuous support from the Office of the Vice-President of Guyana, the Guyana Wildlife Conservation and Management Commission (GWCMC), the Ministry of Amerindian Affairs, the Environmental Protection Agency, the Ministry of Agriculture Fisheries Department, the Kanuku Mountains Communities Representative Group (KMCRG) and the Jacksonville Zoo and Gardens.

This study could not have happened without the dedication of community members, local experts, researchers from various institutions, technical staff from the Sustainable Wildlife Management (SWM) Programme in Guyana and the professional photographers to whom we extend our sincere gratitude. Finally, we would like to express our gratitude to the European Union, for its constant involvement and support to the SWM Programme in Guyana since 2018.

Key local partners:



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The Rupununi River from above

Introduction

The Rupununi region is the largest of Guyana, measuring 57 750 km^2. It is often referred to as the "Land of Giants" based on the healthy populations of large-bodied neotropical species that are found there. Among others are the jaguar (*Panthera onca*), lowland tapir (*Tapirus terrestris*), giant anteater (*Myrmecophaga tridactyla*), giant armadillo (*Priodontes maximus*), giant otter (*Pteronura brasiliensis*), capybara (*Hydrochoerus hydrochaeris*), jabiru (*Jabiru mycteria*), harpy eagle (*Harpia harpyja*), green anaconda (*Eunectes murinus*), black caiman (*Melanosuchus niger*), giant river turtle (*Podocnemis expansa*), gladiator tree frog (*Hypsiboas rosenbergi*), arapaima (*Arapaima gigas*), lau lau catfish (*Brachyplatystoma filamentosum*) and giant water lily (*Victoria amazonica*). Located in the country's southwest, the region consists mostly of large tracts of primary forest, with about 20 percent of its land area covered by natural neotropical savannah and seasonally flooded wetlands. The region stretches from the Acarai Mountains on Guyana's southern border with Brazil to the foothills of the Pakaraima Mountains in the north. It is cleaved east from west by the Rupununi River, which gives the region its name, and north from south by the Kanuku Mountains. Due to its habitat variety, low density human populations, and long history of conservation and traditional management, the Rupununi is likely the most biodiverse region of the country, hosting significant populations of a wide range of important mammal, bird, reptile, amphibian and freshwater fish, as well as key plant species. Importantly, during the rainy season, the Amazon and Essequibo watersheds meet in the North Rupununi, permitting fish migrations and crossover between the Essequibo and Amazon basins. Currently, the region hosts two protected areas: the Kanuku Mountains Protected Area and the Konashen community-owned conservation area.

The Rupununi counts approximately 24 000 inhabitants, mostly belonging to three Indigenous groups: Wai-Wai in the forested deep south, Wapishana in the south savannahs, and Makushi in the north savannahs. Much of the region's land area falls under the Indigenous Titled Lands of 57 Indigenous communities. Additionally, the region includes private homesteads, remnants of the large ranches held by the British Colonial Administration under the 'Rupununi Development Company' and public land. Indigenous Peoples mostly maintain traditional lifestyles of subsistence hunting, fishing and farming, but many actually have mixed livelihoods that include subsistence and cash-earning activities. Market dependence varies within and among communities. Mixed farming involves the cultivation of crops such as cassava, peanuts, bananas, and a variety of other fruits and vegetables. Selling of fish and wildlife for meat or

the live animal trade also contribute supplementary income to many subsistence resource users. Employment in governmental institutions generates most income followed by logging, agroprocessing, cattle ranches, tourism, mining, and production of non-timber forest products and crafts.

Wildlife is at the heart of the identity and livelihoods of the Rupununians, who maintain a strong connection with wildlife through culture, food, medicine and livelihoods. This connection is evident in the various traditions of people, especially stories, myths and beliefs that embody different cultural practices. All traditional livelihood activities are carried out following traditional seasonal calendars, which follow wildlife cycles. Fish and wildlife make a key contribution to food security in the Rupununi, and rank among the top five livelihood activities throughout the region. Tourism, a growing sector in the Rupununi, is intimately linked to wildlife conservation and management, with bird watching, wildlife observations and wild landscapes being the main attractions for visitors. Sport fishing attracts nationals from different parts of the country as well as international anglers. The wildlife trade also generates a substantial income through the national and international pet trade of macaws, parrots, song birds and several amphibian, reptile and arthropod species.

While the Rupununi has seen several boom-and-bust industries over its history (natural rubber, cattle, logging and mining), it has remained sparsely populated and remains a wilderness region. However, the prospects for a rapidly growing oil sector are translating into new infrastructure developments, increased wealth and large investments in the agro-industrial, mining and infrastructure development sectors with possible impacts on wildlife or the habitats on which wildlife depends. With increased connection to markets, particularly to Brazil, cultural identity and traditions are fading, and Indigenous leaders are struggling to keep the younger generation interested in their territory, their culture and their wildlife. Besides, recent years have shown clear signs of climate variability with extreme droughts, fires and floods that do not correspond to the natural, historical patterns of weather in the Rupununi. Such changes affect wildlife and particularly fish populations that depend on a yearly connection between the Essequibo watershed in Guyana and the Amazon watershed for their migration and reproduction. Moreover, these extreme weather patterns severely affect accessibility to wild protein, and impact crops, thereby decreasing food security.

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An adult giant anteater strolls through the savannah

In view of the importance of wildlife for the Rupununians and the risks of habitat and wildlife degradation that could occur due to recent large-scale development, community leaders–in close coordination with governmental institutions and local NGOs–have taken the lead in piloting wildlife management and conservation activities across the Rupununi. This book presents the results of five years of work led by community members, with support from local civil society organizations (e.g. Visit Rupununi, Caiman House, South Rupununi District Council, Rupununi Livestock Producers Association, North Rupununi District Development Board and the South Rupununi Conservation Society) with active support from the Guyana Wildlife Conservation and Management Commission and the Fisheries Department. The first section provides a general understanding of the status of fish, mammal and turtle populations in the region. The second section describes the different uses of wildlife through fishing, hunting and turtle consumption. The third section informs about the possible impacts of anthropogenic activities on wildlife, particularly focusing on roads, fire and human-wildlife co-existence. The final section describes the management actions taken by local communities to ensure that wildlife is used sustainably and conserved for future generations.

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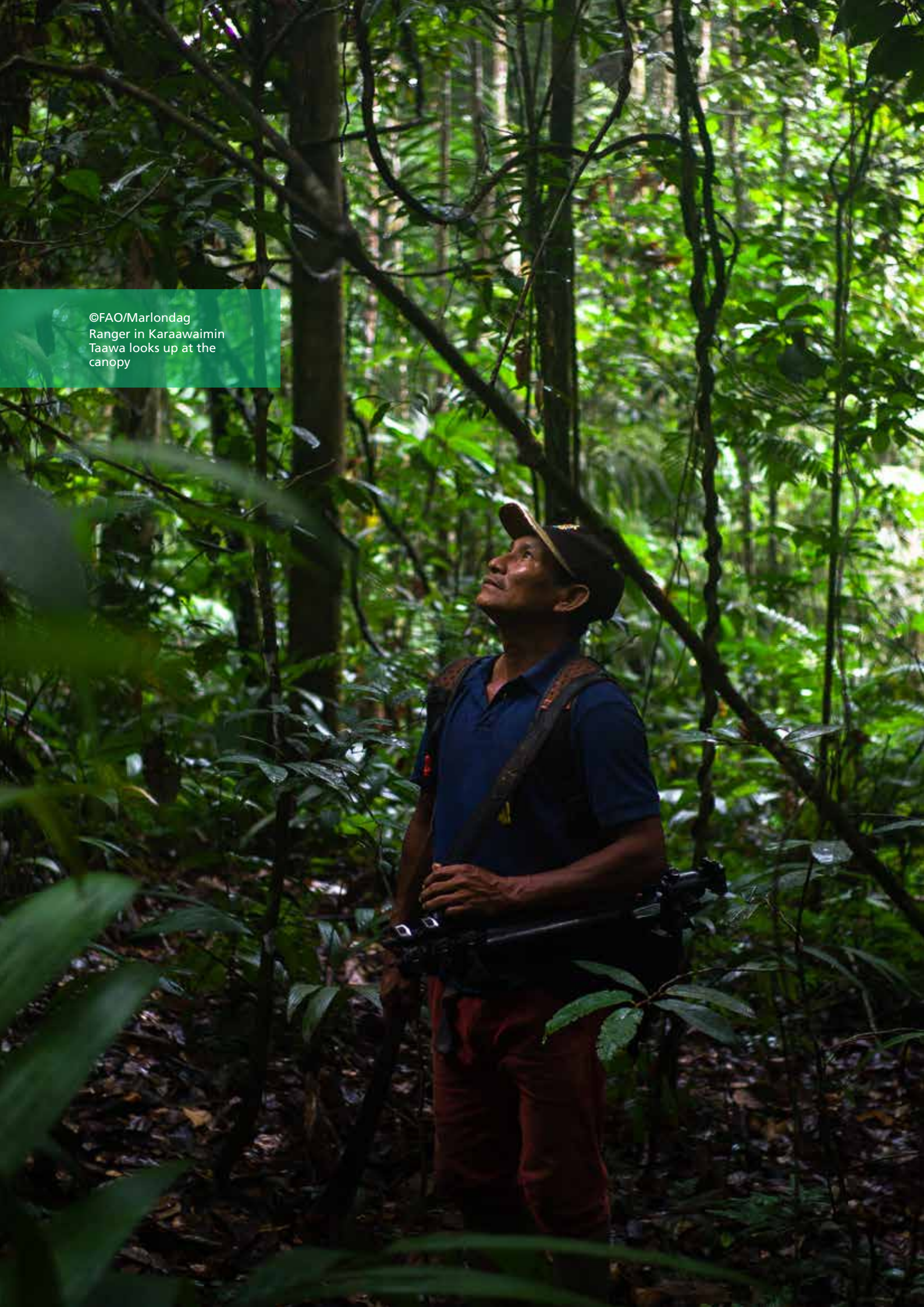
Local fisher Richard Peters having successfully shot a biara



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Ranger in Karaawaimin Taawa looks up at the canopy

1. Status of wildlife populations

1.1. Medium- and large-bodied terrestrial mammal communities in Makushi and Wapichan Indigenous titled lands in the Rupununi, Guyana

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Highlights

- Amazonian savannahs are dynamic and poorly understood ecosystems that support important biodiversity and are currently facing significant threats.
- To better understand savannah mammal communities, and the factors that determine their abundance and distribution, we carried out a region-wide camera-trap study across 199 sites and the major forested habitat types of the Rupununi region.
- Our study has confirmed the presence of at least 47 mammal species in the Rupununi region including threatened species like lowland tapir (bush cow), giant anteater, white-lipped peccary (large bush hog), giant armadillo and jaguar (tiger).
- We found that mammal community occupancy is positively correlated with forest cover and distance to a village, and negatively correlated with gallery forest habitat.
- While our results suggest that the Rupununi region has healthy populations of game species, it is crucial to closely monitor the sustainability of hunting practices, particularly in light of the rapid changes occurring in the region.

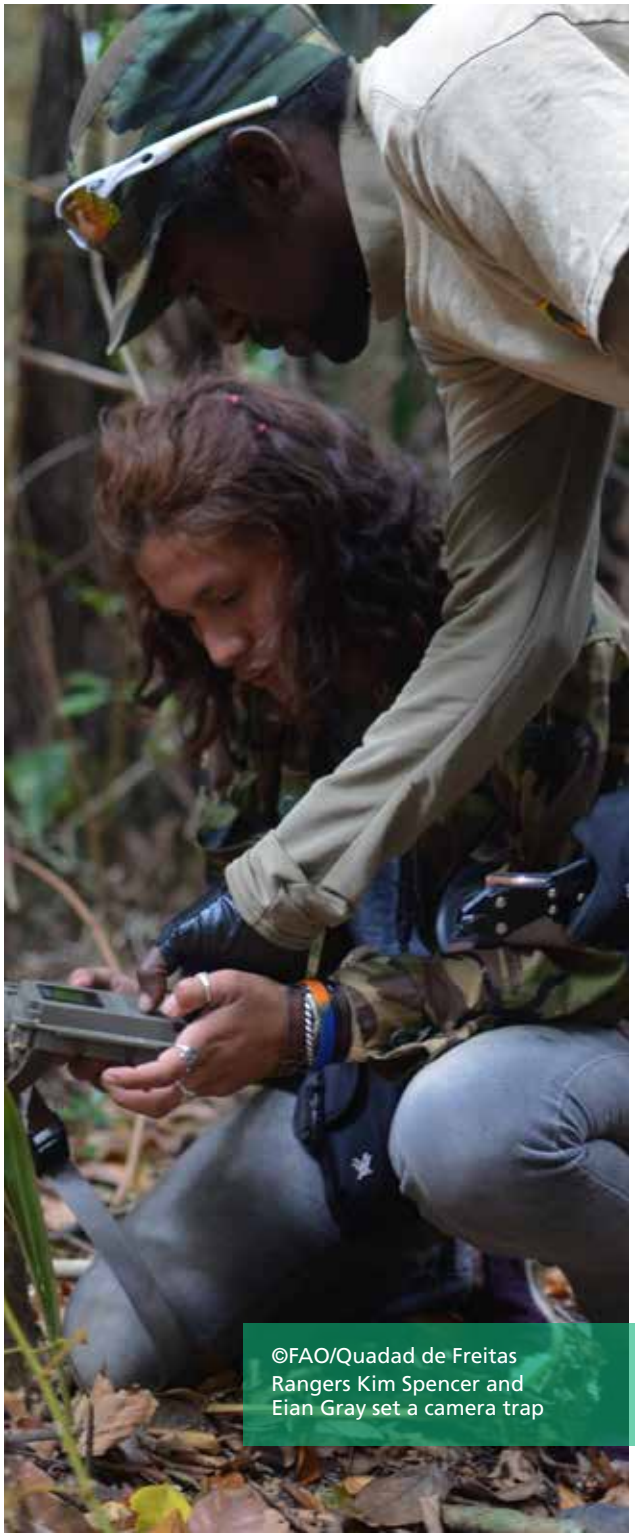
Introduction

Savannahs are the second-largest habitat type in South America covering approximately 269 million hectares (ha) (Ratter *et al.*, 2003), and support unique and diverse plant and animal communities. Savannah-forest habitats are transition zones that form at the boundaries between savannah and forest habitats and are typically considered areas with increased biodiversity because they support a combination of the plant and animal communities found in forests, savannahs and habitats in between. In the Rupununi savannahs of southwest Guyana, savannah-forest habitats are found along the edges of gallery forest, bush islands, and intact lowland and upland forest. Savannah-forest habitats have been recognized as valuable habitats for large mammals, as they provide food and cover, and serve as pathways for movement of forest-dwelling species through open savannah habitats (Risser, 1990). The plants and animals found in savannah-forest habitats are generally dictated

by a combination of local climate, elevation, soil, proximity to water, herbivory and fire (Furley *et al.*, 1992; Hoffmann *et al.*, 2012). Though savannah-forest habitats may contain a higher number of species than nearby lowland and upland forests, large mammal densities are typically reduced because these habitats are generally smaller in size, may contain less available food, and may be far from other forested areas within the landscape (Bowers and Matter, 1997).

The erosion of savannahs across South America due to the expansion of agriculture, cattle grazing, mining and infrastructure development, as well as uncontrolled burning, directly impacts on mammal populations (de Marco *et al.*, 2020). This is of particular concern for the Indigenous Peoples that depend on wildlife for food and livelihoods (de Paula *et al.*, 2017). Large home range and resource requirements, and slow growth and maturity of large mammal species make them particularly sensitive to disturbances by humans, including habitat degradation and overhunting (Purvis *et al.*, 2000). The combination of access to savannah and forest resources also means that savannah-forest habitats often exist in close proximity to communities that depend on wildlife for food and livelihoods (de Paula *et al.,* 2017). Mammal assemblages in savannahs within the Amazon region remain largely understudied despite their importance as a major source of protein and livelihoods for Indigenous Peoples who maintain largely traditional subsistence lifestyles based on farming, hunting and fishing (Read *et al.*, 2010). As the ecotourism sector in the region started growing in the 1990s, large mammals also became one of the main attractions for international visitors to the Rupununi savannahs.

In order to contribute to a better understanding of large mammals across Rupununi savannah-forest habitats, and the influence of natural features and human activities on their abundance and distribution, we carried out a region-wide camera-trap study focused on the savannah-forest habitats within Makushi and Wapichan Indigenous lands. Understanding the diversity, abundance and distribution of mammal species is essential for both traditional and modern local livelihoods. Monitoring of large mammal species serves as an important tool for assessing overall ecosystem health and ensuring that traditional livelihood activities may be sustained into the future.



©FAO/Quadad de Freitas
Rangers Kim Spencer and Eian Gray set a camera trap

Methods

Camera trap photos were collected as part of a camera-trap study of the Rupununi region, following well-established methods for research (Silver, 2004). Camera traps (Bushnell Trophy Cams #119837 and #119876; Bushnell®, Kansas, USA) were set 2 km to 3 km apart, with a single camera at each trap location, set 30 cm to 40 cm from the ground in proximity to an observed animal sign. Cameras were active 24 hours per day, with a one-second delay between captures, recording the date and time with each three-image sequence. In an effort to reduce wariness around cameras, no scents or lures were used, and all cameras employed were equipped with infrared flash.

To avoid bias in sampling and increase understanding of the impact of variables of interest, camera trap locations were selected across sub region, habitat type and season (see Table 1), as well as trail type, distance to water, distance to human settlement, and presence of hunting. Key limiting factors were permission from the communities, accessibility, and threat of flood and fire. Camera traps were set in clusters of 20 cameras, left for a duration of eight to 177 trap nights (average = 89.5 trap nights), and then shifted to a second location using the same sampling protocol. The first sampling period occurred during the rainy season (May to August), followed by a second sampling period in the dry season (September to April). Overall, 199 sites were sampled from May 2019 to March 2020, totalling 16 382 trap nights, 485 953 photographs and 24 800 occasions.

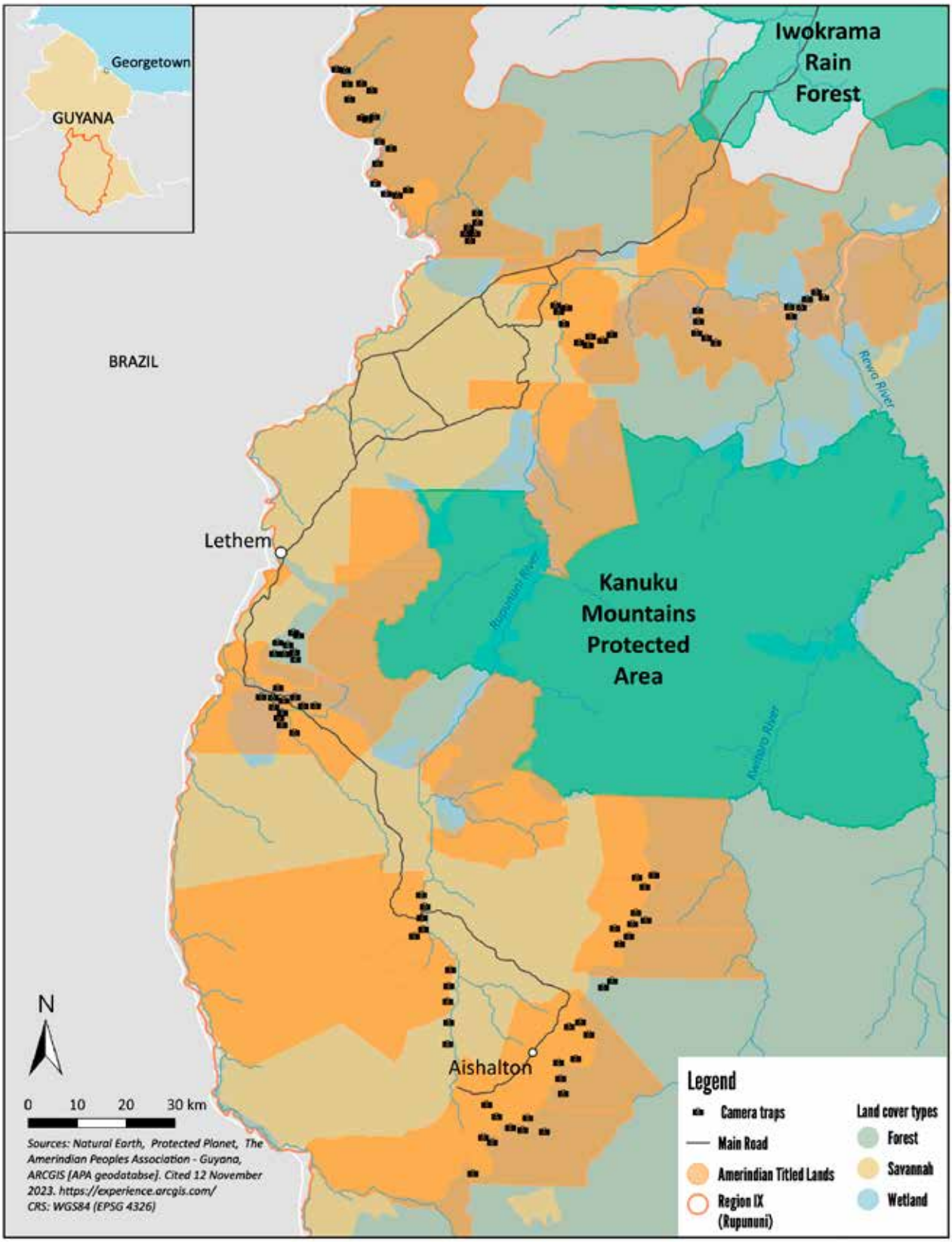
Habitat type was characterized visually using the descriptions in Table 2. Forest cover was determined by placing a 1-km buffer around each camera trap and calculating the percent age of forest cover within each buffer (Hansen *et al.,* 2013). The relationship between habitat type and forest cover is shown in Figure 2. Distance to village was determined by calculating the straight-line distance (in metres) from each camera trap to the nearest village. Season was determined by the date range during which each camera was active, and trail type was determined visually at each camera location. All spatial analyses were conducted in ArcMap 10.4.1 (Environmental Systems Research Institute (ESRI), 2016).

Table 1. Number of camera trap sites per sub district (columns) classified per season, habitat type, trap nights, pictures and occasions

	South Pakaraimas	North Rupununi	Central Rupununi	South Rupununi	Deep South Rupununi	Total
Habitat type	**(# of cameras) dry season / rainy season**					
Upland forest	10 / 16	0 / 0	6 / 16	0 / 0	0 / 0	**16 / 32 (48)**
Lowland forest	0 / 0	10 / 8	1 / 4	8 / 20	4 / 0	**23 / 32 (55)**
Bush island	10 / 4	2 / 10	2 / 0	2 / 0	0 / 20	**16 / 34 (50)**
Gallery forest	2 / 0	8 / 2	11 / 0	8 / 0	15 / 0	**44 / 2 (46)**
TOTAL	**22 / 20 (42)**	**20 / 20 (40)**	**20 / 20 (40)**	**18 / 20 (38)**	**19 / 20 (39)**	**99 / 100 (199)**
Trap nights	(total)					
Trap nights	3 892	3 338	3 232	3 139	2 781	**16 382**
Photographs	64 961	66 379	76 072	102 432	176 109	**485 953**
Occasions	4 324	4 414	4 612	7 680	3 770	**24 800**

Source: Authors' own elaboration. 2023.

Figure 1. Map of camera trap locations across habitat types and the five subregions of the Rupununi region of Guyana



The boundaries and names shown and the designations used on this/these map(s) do not imply the expression of any opinion whatsoever on the part of FAO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers and boundaries. Dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

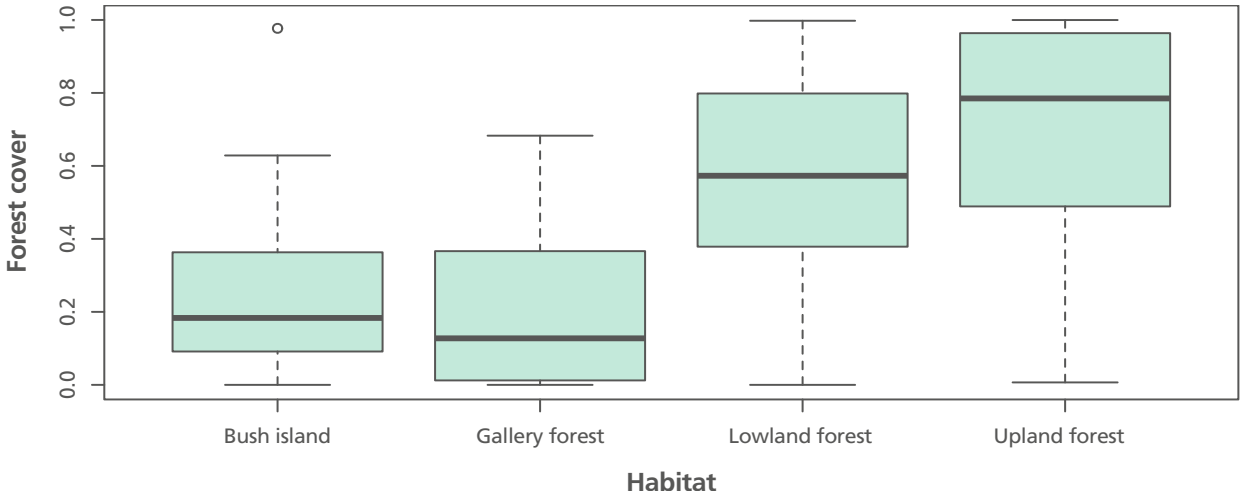
Table 2. Major habitat types of the Rupununi; locations of camera clusters and individual cameras chosen to ensure equal distribution

Habitat type	Description
Lowland mixed tropical forest ©Matthew Hallett	Also known as flooded forests or 'vàrzea', these forests flood seasonally, and as a result, typically contain fewer tree species that are specially adapted to the conditions associated with seasonal flooding. Unlike swamp forests, flooded forests have relatively rich soils from the annual replenishment of nutrients from whitewater rivers. Flooded forest is a mixed forest type, though 'reefs' of mora form in the regularly flooded areas nearest to rivers. Species such as kabukalli and ceiba (known as 'silk cotton' in the Rupununi) are also common in this habitat type, alongside many palms.
Upland mixed tropical forest ©Luke McKenna	Also known as 'terra firme' forest, which literally means 'firm earth', this habitat includes tropical forest that is not seasonally flooded by rivers. Terra firme forest is generally taller and more diverse (more than 400 species/ha in some areas) than flooded forests. It is found only on dry, well-drained soils at elevations between approximately 150 m -1 200 m above mean sea level. Terra firme is a mixed forest type characterized by a wide variety of tropical hardwood trees, including crabwood, greenheart, aromata, wadara, wallaba, kakaralli, balata, purpleheart and many more.
Bush islands ©Luke McKenna	Naturally formed forested islands, known as 'bush islands' in the Rupununi, are typically formed on slightly elevated surfaces within the broader savannah matrix. These islands are used by wildlife, livestock and humans, who all take advantage of their elevation above the seasonal flooding, for shade, cover and food (i.e. fruits and leaves), which contrasts with the otherwise surrounding open savannah. Bush islands provide critical food and cover for browsing herbivores that inhabit the Cerrado savannah, and may serve as 'stepping stones' for dispersing individuals of forest species. The forests are generally composed of a mix of forest, savannah and transitional tree species, with bulletwood, red cedar and angelim commonly sought for timber.
Gallery forest ©Luke McKenna	Within the Cerrado savannah landscape, gallery forests accompany the borders of rivers, creeks and streams, protecting aquatic ecosystems from substrate input, reducing water temperatures, and preventing the erosion of riverbanks. Gallery forests are typically much shorter than other forest types, but can be very dense, highly closed canopy forest habitats. Gallery forests provide critical food and cover for browsing herbivores that inhabit the Cerrado savannah and may serve as corridors for dispersing individuals of forest species. Gallery forests range from palm forests dominated by moriche palm (known as 'ité' in Guyana) to a mix of savannah and flooded forest tree species like mora and ceiba.
Open savannah grasslands ©FAO/David Mansell-Moullin	Open savannah grassland vegetation in the Rupununi consists largely of perennial bunch grasses and a shrub layer dominated by the cayambe tree. Shrub density varies, based on soil moisture, nutrients and history of fire, with hilltops covered by forest fragments, depressions with flooded savannahs, and the boundaries of rivers, creeks and ponds flanked by riparian forest. Open savannah grasslands were excluded from sampling in this study due to complications presented by the threats of fire (dry season), flood (rainy season), equipment malfunction (from direct sunlight) and false triggers (caused by blowing grasses).

Source: Author's elaboration based on Hallett, M.T. et al. (2020) and also drawing on Hallett, M.T. et al. 2024.
Hallett, M.T., Li, F.M., Wilson, A., Barnabas, H., Albert, A., Li, R., da Silva, D., Melville, J., Davis, M., Li, C. Gray, E. 2020. SWM Guyana Programme Large Mammal Monitoring Final Report. Guyana Wildlife Conservation and Management Commission (GWCMC) and Center for International Forestry Research and World Agroforestry (CIFOR-ICRAF). Georgetown, Guyana.
Hallett, M.T., Rovero, F., van Vliet, N., Li, F.M., Li, R., Melville, J., Wison, A., Barnabas, H., Albert, A., da Silva, D., Earl, E., David, O, Quintero, S. 2024. Drivers of medium- and large-bodied terrestrial mammal assemblages within a savanna-forest mosaic on Makushi and Wapichan customary lands in the Rupununi, Guyana. Oryx.

We included 30 species of ground-dwelling mammals with body mass under 2 kg in our analysis of the camera trap data, as these species are most effectively detected by camera traps. We analysed camera trap data using occupancy modelling, which calculates the proportion of days when a species was photographed at each camera (1 = present, 0 = absent) and compares the probability that a species was present across sites that are grouped by the variables of interest described above. We applied these analyses to both the mammal community as a whole and to 30 individual species using a Bayesian framework (adding 10 000 model simulations to the data collected from the field) using the software programme JAGS (version 4.3.0; Plummer, 2003) via R (version 4.1.2; R Core Team, 2017) with the R2 jags (version

Figure 2. Percentage of forest cover (i.e. 0.6 = 60% forest cover) at each camera trap location grouped by habitat type (gallery forest, bush island, upland forest, lowland forest) across 195 camera trap locations in Guyana



Source: Authors' own elaboration. 2023.

0.7-1; Su *et al.*, 2015) package. We also estimated the number of species (species richness) at each site and across all the sites sampled, and calculated the relative abundance index (number of photos of each species/number of trap nights x 100) for each species.

Results

Camera traps documented 47 mammal species in total across all sites (see Table 3) and surveys (34 in Deep South Rupununi, 33 in South Pakaraimas, 33 in South Rupununi, 32 in Central Rupununi and 30 in North Rupununi). This list includes seven species of non-native, domestic mammals (domestic cat, dog, horse, donkey, cow, pig and human). There were 43 species detected during dry season sampling and 39 during the wet season. Camera traps documented a total of ten species of carnivores, 16 omnivores, 16 herbivores and five insectivores. When categorized into standard mammal size classes, cameras documented a total of ten species of small mammal (under 2 kg), 21 medium-sized mammals (2 kg to 15 kg) and 16 large mammals (over 15 kg). Camera traps documented an additional 82 species of birds, 11 reptiles and three amphibians, but these species were not included in our analyses.

Camera trap detections varied greatly, with the following eight species being very common: red-rumped agouti (acouri), ocelot (tiger cat), common opossum (yawarie), nine-banded/greater long-nosed armadillo, giant anteater, red brocket (bush) deer, lowland paca (labba) and tayra (haka). In contrast, six species were very rarely detected: bush dog (short-tailed dog), capybara (watrash), oncilla (baby tiger), white-lipped peccary, southern naked-tailed armadillo and cottontail rabbit. At the community level, mammal species richness tended to increase with forest cover and distance from villages, and was highest in upland and lowland forest, lowest in gallery forests, and intermediate in bush islands.

Average community occupancy (for all 30 species combined) was best predicted by forest cover, with a significant positive effect (preferring larger forested areas), and by distance to villages (preferring areas farther from villages) that tended to have a positive effect (that had a marginally significant positive effect); while distance to roads (preferring areas closer to roads) and livestock detection rate (preferring areas without livestock) tended to have a negative effect. Community occupancy was broadly similar across habitat types with the exception of gallery forest where it was significantly lower than

Table 3. List of mammals captured by the camera traps established across the Rupununi

Scientific name	Common name	IUCN	Size (kg)	Trophic group
Mammalia	**Mammals**			
Felidae	**Cats**			
Panthera onca	Jaguar	Near Threatened	94.5	Carnivore
Puma concolor	Puma	Least Concern	74.5	Carnivore
Leopardus pardalis	Ocelot	Least Concern	11.25	Carnivore
Leopardus wiedii	Margay	Near Threatened	6	Carnivore
Leopardus tigrinus	Oncilla	Vulnerable	2.25	Carnivore
Puma yagouaroundi	Jaguarundi	Least Concern	6.75	Carnivore
Felis catus	Domestic cat	Least Concern	4	Carnivore
Canidae	**Dogs**			
Speothos venaticus	Bush dog	Near Threatened	6	Carnivore
Cerdocyon thous	Crab-eating fox	Least Concern	5.75	Omnivore
Canis familiaris	Domestic dog	Least Concern	10	Omnivore
Mustelidae	**Weasels**			
Eira barbara	Tayra	Least Concern	4.85	Omnivore
Galictis vittata	Greater grison	Least Concern	2.6	Carnivore
Lontra longicaudis	Neotropical river otter	Near Threatened	10	Carnivore
Procyonidae	**Semi-arboreal carnivores**			
Procyon cancrivorus	Crab-eating raccoon	Least Concern	5.4	Omnivore
Nasua nasua	South American coati-mundi	Least Concern	5.1	Omnivore
Tapiridae	**Tapirs**			
Tapirus terrestris	Lowland tapir	Vulnerable	238.5	Herbivore
Equidae	**Horses**			
Equus caballus	Domestic horse	Least Concern	400	Herbivore
Equus asinus	Domestic donkey	Least Concern	250	Herbivore
Cervidae	**Deer**			
Mazama americana	Red brocket deer	Data Deficient	36	Herbivore
Mazama nemorivaga	Amazonian brown brocket deer	Least Concern	18	Herbivore
Odocoileus cariacou	Venezuelan white-tailed deer	Least Concern	40	Herbivore
Tayassuidae	**Peccaries**			
Tayassu pecari	White-lipped peccary	Vulnerable	35	Omnivore

Scientific name	Common name	IUCN	Size (kg)	Trophic group
Pecari tajacu	Collared peccary	Least Concern	26	Omnivore
Suidae	**Pigs**			
Sus scrofa	Domestic pig	Least Concern	100	Omnivore
Bovidae	**Ruminants**			
Bos taurus	Domestic cattle	Least Concern	700	Herbivore
Caviidae	**Cavies**			
Hydrochoerus hydrochaeris	Capybara	Least Concern	50	Herbivore
Cuniculidae	**Pacas**			
Cuniculus paca	Lowland paca	Least Concern	9	Herbivore
Dasyproctidae	**Agoutis**			
Dasyprocta leporina	Red-rumped agouti	Least Concern	4.45	Herbivore
Myoprocta acouchy	Red acouchi	Least Concern	1.25	Herbivore
Sciuridae	**Squirrels**			
Sciurus aestuans	Brazilian squirrel	Least Concern	0.19	Herbivore
Echimyidae	**Spiny rats**			
Proechimys cuvieri	Cuvier's spiny rat	Least Concern	0.65	Herbivore
Proechimys hoplomyoides	Guyanan spiny rat	Least Concern	0.28	Herbivore
Leporidae	**Rabbits**			
Sylvilagus sp	Unidentified rabbit species	n/a	1	Herbivore
Dasypodidae	**Armadillos**			
Priodontes maximus	Giant armadillo	Vulnerable	25.6	Insectivore
Dasypus sp	Nine-banded / great long-nosed armadillo	Least Concern	4.5	Insectivore
Cabassous unicinctus	Southern naked-tailed armadillo	Least Concern	3.2	Insectivore
Myrmecophagidae	**Anteaters**			
Myrmecophaga tridactyla	Giant anteater	Vulnerable	30.5	Insectivore
Tamandua tetradactyla	Southern tamandua	Least Concern	6	Insectivore
Didelphidae	**Opossums**			
Didelphis marsupialis	Common opossum	Least Concern	1.09	Omnivore
Philander opossum	Grey four-eyed opossum	Least Concern	0.43	Omnivore
Metachirus nudicaudatus	Brown four-eyed opossum	Least Concern	0.48	Ominvore
Marmosops sp	Mouse opossum sp.	Least Concern	0.02	Omnivore
Callitrichidae	**Tamarins**			
Saguinus midas	Golden-handed tamarin	Least Concern	0.54	Omnivore

Scientific name	Common name	IUCN	Size (kg)	Trophic group
Cebidae	**Small monkeys**			
Saimiri sciureus sciureus	Common squirrel monkey	Least Concern	0.94	Omnivore
Sapajus apella	Brown capuchin	Least Concern	3.08	Omnivore
Cebus olivaceus	Wedge-capped capuchin	Least Concern	2.66	Omnivore
Atelidae	**Large monkeys**			
Alouatta macconnelli	Guyanan red howler monkey	Least Concern	7.35	Herbivore
Hominidae	**Great apes**			
Homo sapiens	Human	Least Concern	65	Omnivore

Source: Authors' own elaboration. 2023.

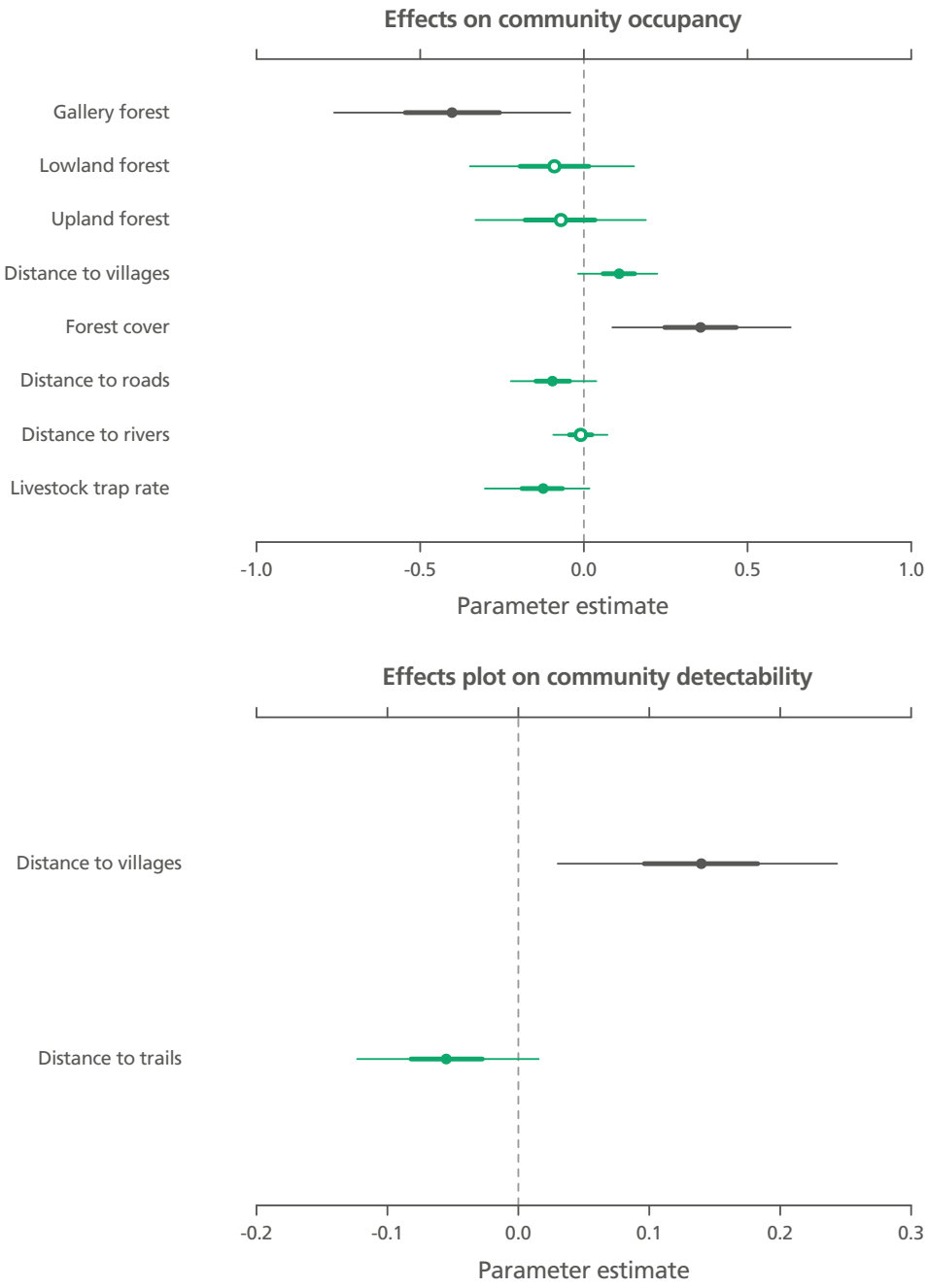
©FAO/Marlondag
Vaquero Richard Peters leads the herd to the ranch

average. Average community detectability was positively and significantly associated with distance to villages, possibly indicating greater elusiveness near human activities, while distance to roads tended to have a negative effect (see Figure 3).

Forest cover was the most important variable in determining the occupancy of individual species, with 15 species showing a significant positive association with forest cover, and three species a significant negative association (savannah deer, giant anteater and savannah fox). Twelve species were not significantly effected by the percentage of forest cover (see Figure 3).

The negative effect of gallery forest habitat that

Figure 3. Influence of covariates on community occupancy and detectability



Source: Authors' own elaboration. 2023.

was significant at community level, was emphasized by significant negative effects at species level for red brocket deer, tayra, long-nosed armadillos, and red-rumped agouti. Interestingly, the effect of gallery forest on occupancy tended to be positive for the capybara and jaguarundi (haka tiger). Distance to villages was significantly positively associated with the occupancy of five species: lowland tapir, four-eyed opossum, collared peccary (small bush hog), red acouchi and brown brocket (small bush) deer (preferring areas farther from villages). Similarly, distance to roads was positively associated only with puma (deer tiger) occupancy (preferring areas farther from roads), while negatively associated to crab-eating racoon (crab dog), giant anteater, common opossum and red-rumped agouti (preferring areas closer to roads). Interestingly, livestock detection rate was positively and significantly associated only with jaguar occupancy (preferring areas with more livestock), while being negatively associated with lowland paca and long-nosed armadillo (preferring areas with less livestock).

Discussion

Our study confirmed the presence of 30 native medium- and large-bodied mammal species in the Rupununi, a number comparable to that of other rich neotropical savannahs, such as the Pantanal (Trolle, 2003). We also confirmed the presence of ten species of carnivores, including jaguar, puma, margay (labba tiger), oncilla and bush dog, attesting to healthy populations of game species. Trends in the occupancy of species with low detection are not discussed in detail because they were either not effectively surveyed by the design of the camera trap survey (greater grison, naked-tailed armadillo, margay, tayra) or they are naturally rare or wide-ranging (bush dog, white-lipped peccary, giant armadillo).

©FAO/Marlondag
A red-rumped agouti seen roaming in the early morning

Jaguars and livestock

In this study, the presence of jaguars was significantly positively correlated with the presence of livestock, meaning that they showed a preference for areas where livestock are more abundant. Jaguars are opportunistic predators that have been documented preying on 111 species across their range (Hayward *et al.,* 2016) and are regularly implicated in predation of livestock, especially cattle (de Azevedo and Murray, 2007). The frequency of predation of livestock by jaguars has been shown to increase with the area over which livestock are allowed to graze (Montalvo *et al.,* 2016). Open savannah grasslands naturally support a limited number and abundance of native prey species; however, the introduction of cattle, which graze out in the open and often wander into forested habitats in search of food and water, may have actually increased jaguar populations within Rupununi savannah and savannah-forest habitats. The improved livestock management strategies discussed in Chapter 3.3 of this book may help reduce predation of livestock by jaguars, pumas and other wild carnivores.

Distance to roads

A number of species showed a significant preference for inhabiting areas near to roads – giant anteater, red-rumped agouti, crab-eating raccoon, common opossum, and four-eyed opossum. Each of these species is known to benefit from the disturbance associated with roadsides, as raccoons forage in drainage ditches, opossums scavenge, and agoutis feed on fruits, seeds, roots and fresh shoots. Giant anteaters are a protected species in Guyana and are susceptible to roadkills because of their tendency to freeze in place rather than fleeing when a vehicle is approaching on the road (Paemelaere *et al.*, 2023). The preference for certain species to use areas along roadsides has important implications for the proposed upgrades to the Georgetown-Lethem highway. The construction of road underpasses, speed bumps and other strategies discussed in Chapter 3.2 of this book may be important strategies for reducing roadkills of anteaters and other species when vehicle speed and traffic inevitably increases with the paving and upgrading of the highway.

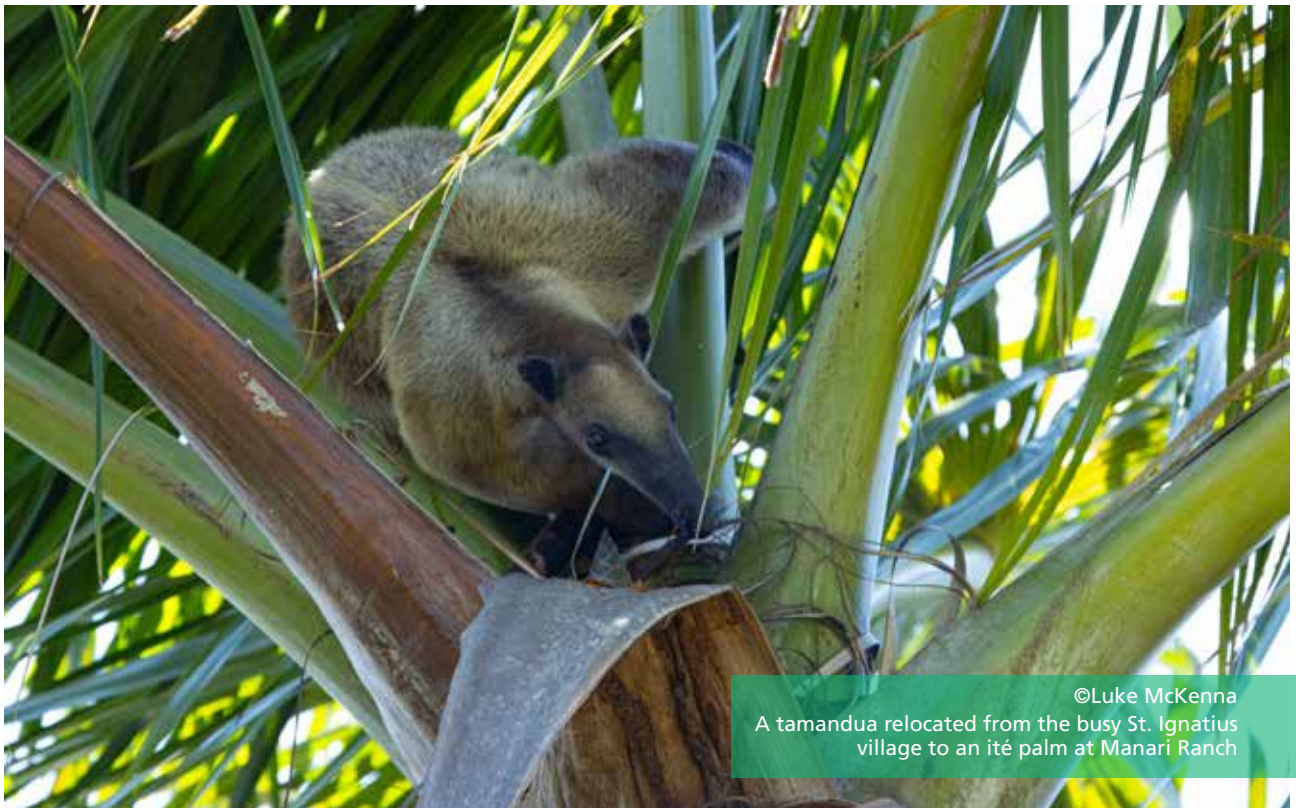
©FAO/Luke McKenna
Giant anteater walking in the cooler hours of the day

Forest cover and habitat type

Forest cover showed a significant positive relationship with the medium- and large-bodied mammal community as a whole, as well as half (15/30) of the species tested. This trend stands to reason for semi-arboreal species like margay, tayra, common opossum and four-eyed opossum, who depend on tree canopies to hunt, forage or rest. Forest cover also showed a significant positive relationship with a variety of game species (tapir, brocket deer, collared peccary, paca, agouti, acouchi) that depend on the fruits and seeds of forest trees, palms and vines. The presence of puma was also positively correlated with forest cover, as a species that primarily feeds on wild game species (deer and agouti) (Foster *et al.*, 2010). These results reiterate that the Rupununi's large, intact forested areas are the most important habitats for supporting populations of medium- and large-bodied mammals, especially the game species that are preferred by subsistence hunters.

Lowland and upland forest are largely intact, and have been managed for generations using the traditional management systems of the Makushi, Wapichan and Wai Wai communities of the Rupununi region. Lowland forest habitats near the boundary between forest and savannah may be some of the most diverse in the entire region because of the mixing of distinct forest and savannah plant and animal communities. These habitats are also at the highest risk due to the increase in the frequency and duration of savannah fires resulting from a hotter, drier climate, as well as the loss of traditional fire management practices (Mistry *et al.*, 2016). In fact, savannah fire along forest edges and the transition from forest to savannah that often follows the burning of forest edges is the leading driver of forest loss in the Rupununi region (Global Forest Watch, 2022).

Forest cover showed a significant negative relationship with the presence of traditionally 'savannah-dwelling' species – crab-eating fox, white-tailed (savannah) deer and giant anteater. Another six species (southern naked-tailed armadillo, southern tamandua, capybara, crab-eating



©Luke McKenna
A tamandua relocated from the busy St. Ignatius village to an ité palm at Manari Ranch

raccoon, South American coati [Kwash], jaguarundi) had weak negative relationships with forest cover, showing a preference for forests but an ability to also utilize savannah-forest habitats by readily feeding on grasses, insects (ants/termites), or a generalized omnivorous diet. Large mammal community occupancy also showed a significant negative relationship with gallery forest habitats. While individuals of some forest-dwelling species do make seasonal use of gallery forests for movement or to take advantage of ité palm fruits, these habitats flood regularly which may limit the movement of some species during parts of the year. While a few species that are also strong swimmers (capybara, jaguarundi) showed a slightly positive relationship with gallery forests, it is likely that seasonal flooding is the driving factor behind nearly every species (28/30) showing a negative relationship.

Bush islands showed the highest mammal community occupancy of all habitat types, potentially due to their accessibility to both savannah and forest-dwelling species. While savannah species (fox, savannah deer, anteater) may make use of the cover provided by all bush islands, the size of each individual bush island, and its proximity to other bush islands within a network of forested bush islands spread across the landscape, is likely the most important factor in predicting the use of these habitats by forest-dwelling species. However, the increasing centralization of Rupununi villages due to commitments to schools and churches has also increased the threats to bush islands. The number of community members who maintain traditional rotational agriculture in lowland and upland forest sites far from villages has dramatically decreased, and instead, many villagers now choose to farm in nearby bush islands (H. Barnabas, personal communication, 2019). Increased demand for nearby hardwood trees to supply growing village populations with timber for houses and fence posts for livestock ranching has also resulted in unsustainable removal of large trees from many bush islands (A. Wilson, personal communication, 2019). Savannah fires set to rejuvenate grasses may also burn bush islands at the edges, resulting in forest loss. Bush islands are also favoured by Indigenous hunters during the rainy season – both because fishing is more difficult, and game species tend to congregate on these hilltop habitats when the surrounding savannah is flooded (F. Li, personal communication, 2018). The importance of bush islands for a high number of medium- and large-bodied mammal species makes improving the management of these habitats, especially larger islands and those in close proximity to intact forest, particularly important.

©Luke McKenna
A fire passes through the savannah and into the bush

Distance to villages

Community occupancy also showed a positive and marginally significant relationship with distance to village (meaning most species prefer areas further from villages), possibly indicating the effect of hunting pressure. Most hunting in the Rupununi occurs 6 km to 12 km from village centres (Read *et al*., 2010). Recent studies within the neighbouring Iwokrama forest and Kanuku Mountains detected only weak negative effects of hunting within intact forest habitats where the majority of sampling locations were at distances greater than 20 km from any village (Roopsind *et al.,* 2017; Hallett *et al.,* 2019). This study focused exclusively within savannah-forest habitats, the majority of which are near to villages and therefore within subsistence hunting areas used by Rupununi communities. In addition to the increased hunting pressure, savannah-forest habitats are also smaller, patchier and exposed to the effects of fire, flooding, farming, roads and livestock discussed above. The combined effect of all these factors may be driving the contrasting significant effect of distance to village on the mammal communities within savannah-forest habitats when compared to the weak effect in nearby intact forests.

At the species level, several frequently hunted species showed positive relationships with distance to village (meaning that they are more common in areas far from villages). Lowland tapir and collared peccary showed a significant positive relationship, while red brocket deer, lowland paca and long-nosed armadillos all showed weak positive relationships with distance to village. Two savannah-dwelling game species, white-tailed deer and capybara, showed weak negative relationships, indicating that they, too, are more common in areas farther from villages. By comparison, in the Kanuku Mountains the mammal community showed no relationship with hunting intensity, and only lowland tapir, giant armadillo and lowland paca showed weak negative correlations with hunted areas (Hallett *et al.,* 2019). The fact that mammal community occupancy, along with a variety of commonly hunted game species, all showed positive correlations with distance to village indicates that current levels of hunting in Rupununi savannah-forest habitats are having an impact that warrants concern, and that the implementation of management strategies would improve sustainability.

Conclusion

Currently, about 17 percent of savannah-forest habitats of the Amazon region are within Indigenous lands, while only 13 percent are within protected areas (de Carvalho and Mustin, 2017), indicating that Indigenous communities have a major role to play in supporting the conservation and management of neotropical savannah ecosystems. Overall, at the community level, our results call for closer attention to the management of forested areas and the sustainability of hunting within savannah-forest habitats in close proximity to communities. Though hunting in the Rupununi is still primarily done with traditional methods (bow and arrows) for subsistence purposes, our study suggests that natural factors (fire, flooding) within savannah-forest habitats result in naturally reduced densities of game species. Makushi and Wapichan Indigenous communities in the Rupununi maintain title to their lands; thus, the proposal of hunting management strategies could improve sustainability within the most accessible hunting areas. Further, improving management strategies for fire, timber harvest and agriculture within bush islands and along the edges of lowland forests would also benefit populations of large forest-dwelling mammals. Implementation of improved livestock management and roadkill mitigation structures would help reduce conflict with species of conservation concern, the jaguar and giant anteater, respectively.

Recommendations

1. **Hunting management strategies** (i.e. protection of sacred sites, better control of outsiders, village rules and zoning, and promotion of traditional hunting methods) are proposed to improve the sustainability of hunting within the most accessible hunting areas.

2. **Bush island management strategies** (i.e. management of timber harvest, replanting of large trees, limiting farming) are proposed.

3. **Fire management plans** (i.e. resuming the use of traditional burning calendars, and incorporating the use of firebreaks at forest edges and near bush islands) should be implemented.

4. **Roadkill mitigation structures** (underpasses/large culverts, speed bumps, some fencing along roadways, educational signage) should be incorporated into plans for upgrading the Georgetown-Lethem highway.

5. **Livestock management** (i.e. increased use of corrals, motion-sensor lights, artificial water sources, shade structures, supplemental feed and minerals) should be implemented to reduce conflict with jaguars.

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SRCS rangers check camera traps on a regular basis

References

Barbosa, L.R., Rodrigues, A.P., Soler, L.S., Fernandes, B.V., Castro, B.M.C., Wilcken, C.F. & Zanuncio, J.C. 2017. Establishment in the field of Cleruchoides noackae (Hymenoptera: Mymaridae), an exotic egg parasitoid of Thaumastocoris peregrinus (Hemiptera: Thaumastocoridae). *Florida Entomologist*, 100(2): 372–374. https://doi.org/10.1653/024.100.0237

Battisti, A., Benvegnù, I., Colombari, F. & Haack, R.A. 2014. Invasion by the chestnut gall wasp in Italy causes significant yield loss in Castanea sativa nut production. *Agricultural and Forest Entomology,* 16: 75–79. https://doi.org/10.1111/afe.12036

Bowers, M.A. & Matter, S.F. 1997. Landscape ecology of mammals: relationships between density and patch size. *Journal of Mammalogy*, 78(4): 999–1013.

de Azevedo, F.C.C. & Murray, D.L. 2007. Evaluation of potential factors predisposing livestock to predation by jaguars. *The Journal of Wildlife Management*, 71(7): 2379–2386.

de Carvalho, W.D. & Mustin, K. 2017. The highly threatened and little-known Amazonian savannahs. *Nature Ecology & Evolution*, 1(4): 0100.

de Marco, P., Villén, S., Mendes, P., Nóbrega, C., Cortes, L., Castro, T. & Souza, R. 2020. Vulnerability of Cerrado threatened mammals: an integrative landscape and climate modeling approach. *Biodiversity and Conservation*, 29: 1637–1658.

de Paula, M., Xerente, V. & Pezzuti, J. 2017. Hunting and monitoring: community-based research in Xerente Indigenous Land, Brazilian Cerrado. *Human Ecology Review*, 23(1): 23–44.

Environmental Systems Research Institute (ESRI). 2016. ArcGIS Release 10.4.1. Environmental Systems Research Institute. Redlands, CA, USA.

Foster, R.J., Harmsen, B.J. & Doncaster, C.P. 2010. Habitat use by sympatric jaguars and pumas across a gradient of human disturbance in Belize. *Biotropica*, 42(6): 724–731.

Furley, P.A., Proctor, J. & Ratter, J.A. 1992. *Nature and dynamics of forest-savanna boundaries*. London, UK. Chapman & Hall.

Global Forest Watch. 2022. World Resources Institute. Cited on 3 February 2023. https://www.globalforestwatch.org/dashboards/country/GUY.

Hallett, M.T., Kinahan, A.A., McGregor, R., Baggallay, T., Babb, T., Barnabus, H., Wilson, A. *et al.* 2019. Impact of low-intensity hunting on game species in and around the Kanuku Mountains Protected Area, Guyana. *Frontiers in Ecology and Evolution*, 7: 412.

Hansen, M.C., Potapov, P.V., Moore, R., Hancher, M., Turubanova, S.A., Tyukavina, A. *et al*. 2013. High-resolution global maps of 21st-century forest cover change. *Science*, 342: 850–853.

Hayward, M.W., Kamler, J.F., Montgomery, R.A., Newlove, A., Rostro-García, S., Sales, L.P. & van Valkenburgh, B. 2016. Prey preferences of the jaguar (*Panthera onca)* reflect the post-Pleistocene demise of large prey. *Frontiers in Ecology and Evolution*, 3: 148.

Hoffmann, W.A., Geiger, E.L., Gotsch, S.G., Rossatto, D.R., Silva, L.C., Lau, O.L., Haridasan, M. & Franco, A.C. 2012. Ecological thresholds at the savanna forest boundary: How plant traits, resources and fire govern the distribution of tropical biomes. *Ecology Letters*, 15(7): 759–768.

Mistry, J., Bilbao, B.A. & Berardi, A. 2016. Community owned solutions for fire management in tropical ecosystems: Case studies from Indigenous communities of South America. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 371(1696): 20150174.

Montalvo, V., Alfaro, L., Saenz, C., Cruz, J., Fuller, T.K., Carrillo, E. 2016. Factors affecting jaguar and puma predation on livestock in Costa Rica. *Wildlife Biology in Practice*, 12(1):, 32–42.

Paemelaere, E.A., Mejía, A., Quintero, S., Hallett, M., Li, F., Wilson, A., Barnabas, H., Albert, A., Li, R., Baird, L., Pereiras, G. & Melville, J. 2023. The road towards wildlife friendlier infrastructure: Mitigation planning through landscape-level priority settings and species connectivity frameworks. *Environmental Impact Assessment Review*, 99:, 107010.

Plummer, M. 2003. JAGS: a program for analysis of Bayesian graphical models using Gibbs sampling. Vienna, Austria: Proceedings of the 3rd international workshop on distributed statistical computing.

Purvis, A., Gittleman, J.L., Cowlishaw, G. & Mace, G.M. 2000. Predicting extinction risk in declining species. Proceedings of the Royal Society of London. Series B: *Biological Sciences,* 267(1456): 1947–1952.

R Core Team. 2017. R: A language and environment for statistical computing. R Foundation for Statistical Computing. Vienna, Austria.

Ratter, J.A., Bridgewater, S. & Ribeiro, J.F. 2003. Analysis of the floristic composition of the Brazilian Cerrado vegetation III: Comparison of the woody vegetation of 376 areas. *Edinburgh Journal of Botany*, 60(1): 57–109.

Read, J.M., Fragoso, J.M., Silvius, K.M., Luzar, J., Overman, H., Cummings, A., Giery, S.T. & De Oliveira, L.F. 2010. Space, place, and hunting patterns among indigenous peoples of the Guyanese Rupununi region. *Journal of Latin American Geography*, 9(3): 213–243.

Risser, P.G. 1990. The ecological importance of land-water ecotones. In: R.J. Naiman and H. Décamps, eds. *The ecology and management of aquatic-terrestrial ecotones*, 4: 7–21. UNESCO, Paris.

Roopsind, A., Caughlin, T.T., Sambhu, H., Fragoso, J. & Putz, F.E. 2017. Logging and indigenous hunting impacts on persistence of large Neotropical animals. *Biotropica*, 49(4): 565–575.

Silver S. 2004. Assessing jaguar abundance using remotely triggered cameras, New York, USA, Wildlife Conservation Society.

Su, Y.S. & Yajima, M. 2015. R2jags using R to run JAGS. Available: CRAN. R-project. org/package= R2jags, September 2015. https://cran.r-project.org/web/packages/R2jags/index.html

Trolle, M. 2003. Mammal survey in the southeastern Pantanal, Brazil. *Biodiversity & Conservation,* 12: 823–836.

Camera trap images:

Jaguar

Puma

Bush dog

Crab-eating fox

Tayra

South American coatimundi

Lowland tapir

Collared peccary

Red-rumped agouti

Giant anteater

Brown capuchin

Black curassow

Climbing behaviour of anteaters

By Erin Earl, South Rupununi Conservation Society

The giant anteater (*Myrmecophaga tridactyla*) is a charismatic and enigmatic species. The International Union for Conservation of Nature (IUCN) lists this species as vulnerable with a decreasing population trend due to intensive degradation of its natural habitat, hunting, attacks by domestic dogs, wildfires and roadkill incidents. Despite serving as a charismatic symbol of wildlife across the globe, much is unknown about the behaviour, ecology and physical abilities of the giant anteater.

One aspect of its behaviour that has raised debate among specialists is the species' ability to climb and mark trees. In a recent study conducted in South Rupununi by the Sustainable Wildlife Management (SWM) Programme and the South Rupununi Conservation Society (SRCS), we evidenced the widespread nature of scratching trees as a marking behaviour. We also demonstrated that marking is sometimes associated with tree hugging or tree climbing. While previous observations were only made on isolated occasions, mostly from individuals in captivity, our results show that both behaviours are common among giant anteaters. In our study, most giant anteaters observed on camera traps climbed between 40 cm and 60 cm high.

Marked trees serve as "communication hubs" for giant anteaters, as multiple individuals use them over long periods of time. Our study suggests that tree-marking behaviours involve complex means of visual and chemical communication among giant anteaters. While marking, giant anteaters may rub secretions from glandular skin structures into the tree bark. Although sebaceous or sweat glands have never been described in giant anteaters, they have been identified in the mandibular organ of the closely related silky anteater (*Cyclopes didactylus*). By climbing to mark the tree, the animal may be advertising its competitive or reproductive ability, as well as its dominance status. The height of the mark or scent could be an "index", with higher signals indicating the presence of a dominant individual with the necessary physical characteristics, such as size and strength, to climb a tree.

©FAO/Luke McKenna
Giant anteaters have a good sense of smell; this individual senses someone is near

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SRCS rangers inspect scratch markings made by a giant anteater on a ciambe tree

1.2. Examining nesting patterns and predation risks in yellow-spotted river turtles within the Rupununi

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Highlights

- The study reveals a remarkable density of nests, with an average of 6.68 nests per beach and roughly 14.2 nests per hectare (SD = 8.94), significantly exceeding densities in the Orinoco and Juruá river Basins.
- An average of 20.45 eggs per nest indicates the substantial reproductive output of nesting turtles.
- Nests were predominantly situated within 1 m to 20 m from the river, 0 m to 8 m from the vegetation, and on fine sand, showcasing the preferred nesting sites. Nest temperatures were within 27 °C to 29 °C.
- The study uncovers the critical issue of nest predation, with lizards, humans and birds identified as primary culprits, especially impacting nests located closer to vegetation.
- All nests in sites vulnerable to flooding were relocated to a hatchery in the community of Yupukari, where hatching success reached an impressive 83 percent.

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Yellow-spotted river turtles seen at Caiman House Inc.

Introduction

The yellow-spotted river turtle (*Podocnemis unifilis*) inhabits the Amazon, Orinoco and Essequibo river basins (Pearse, 2006) and is currently listed as vulnerable on the International Union for the Conservation of Nature (IUCN) Red List (2016), with potential reclassification to endangered due to further population declines (Rhodin *et al*., 2018; Norris *et al*., 2019). The eighteenth and nineteenth centuries presented significant declines due to historical exploitation, and despite regulations in the twentieth century, illegal harvesting persisted (Kemenes and Pezzuti, 2007; Peñaloza *et al*., 2013; El Bizri *et al*., 2020). Additional challenges for the species include deforestation (Fagundes *et al*., 2018), water pollution, increased boat traffic (Fachín-Terán and von Mülhen, 2003; Rachmansah *et al*., 2020), climate change, water level fluctuations (Páez *et al*., 2015; Eisemberg *et al*., 2016) and infrastructure development (Norris *et al*., 2018).

The life cycle of *P. unifilis* is closely tied to the region's hydrological patterns, with females migrating to nesting areas during the dry season (Ponce de Leão *et al*., 2019). These nesting sites are typically on riverbanks and fringes of water bodies (Erickson and Baccaro, 2016), with flooding influencing reproductive success (Erickson *et al*., 2020). Clutch size varies based on body size and location, but is usually between 20 to 30 eggs (Hernández *et al*., 2010). Efforts to address the population trends have focused on ecological studies in Brazil, Venezuela and Bolivia (Escalona and Fa, 1998; Ferreira Juniór and Castro, 2010; Conway-Gómez *et al*., 2014; Ponce de Leão *et al*., 2019). In these countries, conservation initiatives, such as nest protection and monitoring, turtle ranching and participatory conservation regimes, have reduced harvest rates and promoted social justice (Páez *et al*., 2015; Campos-Silva *et al*., 2018).

Despite extensive research and conservation efforts, the Essequibo River Basin, vital for this species, remains largely understudied. This knowledge gap poses a significant challenge to effective conservation and management. In response to the pressing need for a deeper understanding of the yellow-spotted river turtle's ecology in the Essequibo River Basin, the community of Yupukari and Caiman House, a community-driven NGO, launched a conservation programme in 2011. This programme encompasses *in-situ* conservation through beach protection and monitoring, as well as *ex situ* conservation involving head-starting activities, turtle consumption tracking, and environmental education.

Since 2020, a research programme has been in place to systematically document nesting characteristics and address critical knowledge gaps regarding this species' ecology. This study presents data on nesting behaviour, wild predation and hatching success as part of the head-starting programme. This information contributes to the development of a comprehensive and participatory conservation programme for this species while preserving the rich cultural and ecological heritage of the Rupununi region.

Material and methods

Study area

This study was conducted in Yupukari, a Makushi community situated in the North Rupununi, Guyana, and encompassing nine beaches (see Figure 4). This region, rich in biodiversity due to its location within the Guiana Shield, is home to three national protected areas: Kanuku Mountains Protected Area (KMPA), Kanashen Amerindian Protected Area (KAPA), and Iwokrama rainforest. Characterized by primary forests, savannahs and seasonally flooded wetlands, the Rupununi is known for its conservation efforts (Paemelaere *et al*., 2022).

Data collection

Nest surveys

Between 2021 and 2023, nine beaches near Yupukari village were surveyed by a team of four to five community members. These beaches were selected due to their historical significance as nesting sites. Surveys were conducted from January to April each year, with nest identification based on turtle tracks in the sand. Site characteristics were recorded, including coordinates, sand grain size, and distances to the river and vegetation.

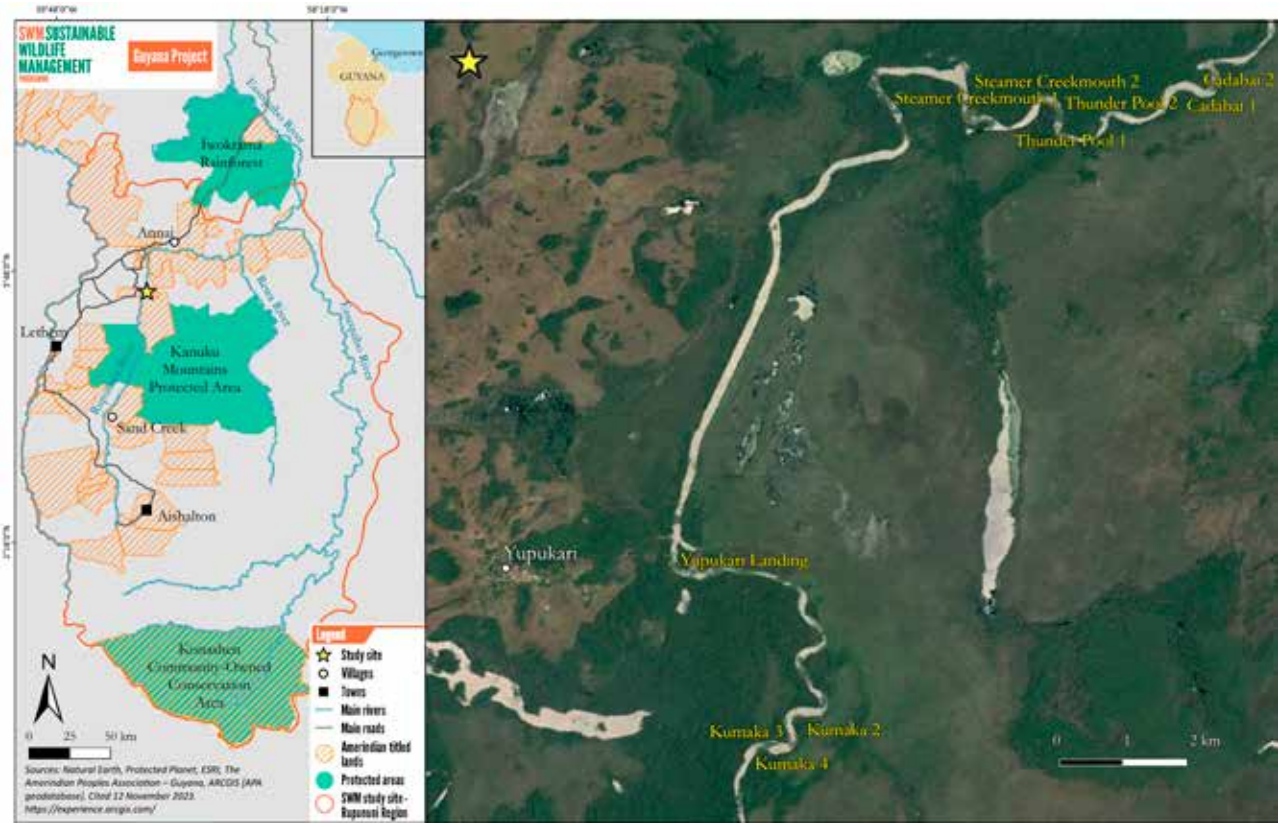
Nest depredation and destruction

Naturally depredated nests were identified by broken eggshells, animal tracks and wildlife excavation marks (Norris *et al*., 2019). Human-induced damage was marked by a 10 cm to 15 cm hole, often associated with signs of human activity. Flooded nests were those submerged due to rising water levels. Early flooding led to the translocation of over half the nests to a hatchery.

Hatchling characteristics

To ensure the safety and healthy development of hatchlings, we followed a protocol that involved promptly collecting eggs from nests at risk of flooding within the first 48 hours of their existence. These eggs were carefully retrieved and stored for off-site management. We maintained meticulous records of nest temperature, depth and size, replicating these conditions in our controlled hatchery environment. The collected eggs were repositioned in plastic basins filled with beach sand to match their original nest depth. Our hatcheries were designed to simulate a natural habitat, measuring 6 m x 6 m with a height of 1 m. We carefully controlled the temperature to achieve a balanced sex ratio. In this controlled hatchery setting, the eggs completed their incubation period, and hatchlings were raised for one month before being released into the wild.

Figure 4. Map of the study area*



**On the left, the Rupununi region, with its three national protected areas, main rivers (Rupununi River, a tributary of the Essequibo), and the location of the two study sites highlighted. Upper right, satellite image (Source: Google Earth) of the north part (Yupukari) showing the ten monitored beaches along the Rupununi River, as follows: C2: Cadabai 2, C1: Cadabai 1, TP2: Thunder Pool 2, TP1: Thunder Pool 1, SC2: Steamer Creekmouth 2, SC1: Steamer Creekmouth 1, YL: Yupukari Landing, K3: Kumaka 2, K2: Kumaka 3, and K3: Kumaka 4*

The boundaries and names shown and the designations used on this/these map(s) do not imply the expression of any opinion whatsoever on the part of FAO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers and boundaries. Dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Data analysis

To compare nest numbers across the monitored years, a generalized linear model (GLM) was used with a negative binomial distribution. To assess the influence of environmental factors on nest site selection, we conducted individual regression models with the number of nests as the response variable, and each of the specified environmental characteristics as predictor variables. The use of separated models was chosen to prevent collinearity issues. For examining the impact of environmental characteristics on nest predation frequency, a generalized linear mixed model (GLMM) with a negative binomial distribution was employed. In this analysis, each beach was considered a random variable.

Collinearity tests confirmed the absence of significant collinearity ($p>0.05$) among predictor variables in the selected models. To validate the suitability of our GLMM and GLM models, residual checks were performed. Model selection was based on the Akaike information criterion ($\Delta AIC > 6$) to identify the most relevant models. All analyses were carried out in R ver. 3.5.3 using the LME4 package (Oksanen *et al.*, 2013; R Development Core Team, 2019).

Results

Nest numbers displayed variation over three years: 59 nests in 2021 (average 1.5 new nests identified per day, SD = 0.4), 72 nests in 2022 (average 2.3, SD = 4.1), and 76 nests in 2023 (average 4.2, SD = 2.3). There were no significant differences in nest numbers between 2022 and 2023 compared to 2021 (see Table 4). However, the overall number of nests showed an increasing trend, with a 2.1-fold rise in 2022 and a 2.6-fold increase in 2023 compared to 2021. The average number of nests per beach was 6.68 (SD = 3.66), with a density of 14.2 nests per hectare (SD = 8.92). Over the years 2021, 2022 and 2023, a total of 1 160, 514 and 1 534 hatchlings were recorded, respectively, with an average of 20.45 eggs per nest (SD = 8.03; ranging from one to 31).

Most nests were situated within 1 m to 20 m from the adjacent river ($p<0.05$), within 0 m to 8 m from the nearest vegetation, and were predominantly located in areas with fine sand substrates. Our data indicated that the temperature conditions of the nests mainly fell within the range of 27 °C to 29 °C ($p<0.05$), (see Table 5 Figure 5).

Nests at risk of flooding were relocated to the community hatchery in Yupukari, where they achieved an 83 percent hatching success rate (see Figure 7). After undergoing a one-month period in water tanks, the hatchlings were released into their natural habitat (see Figure 7). A total of 127 nests were in flooding sites (see Figure 7). In 2021 and 2023, most nests were transferred to the hatchery, while nests in the wild had predation rates of 55.0 percent and 48.8 percent, respectively. Conversely, in 2022, most nests were retained in the natural habitat, with a comparatively lower incidence of predation (17.7 percent). Predation events were primarily attributed to the salipenter lizard (*Tupinambis teguixin*). A total of 127 nests were in flooding sites (see Figure 7), responsible for 66.6 percent of nest predations, followed by human interference and the great black hawk. Our GLMM analysis revealed a statistically significant correlation between the proximity of nests to vegetation and predation rates ($p<0.05$) (see Table 6).

Table 4. Details of the complete model and the null model using a generalized linear mixed model to compare the number of nests in 2022 and 2023, in relation to the number of nests in 2021

Response variable	Predictor variables	Estimate	Std. error	z value	Pr(>|z|)	AIC	AIC null model	ΔAIC	Model
Nest number in 2021	Nest number in 2022	0.003662	0.008388	0.437	0.681	52.221	59.106	6.885	GLMM
	Nest number in 2023	0.082221	0.042079	1.954	0.108				

Source: Braga-Pereira et al. 2023. CIFOR-ICRAF.

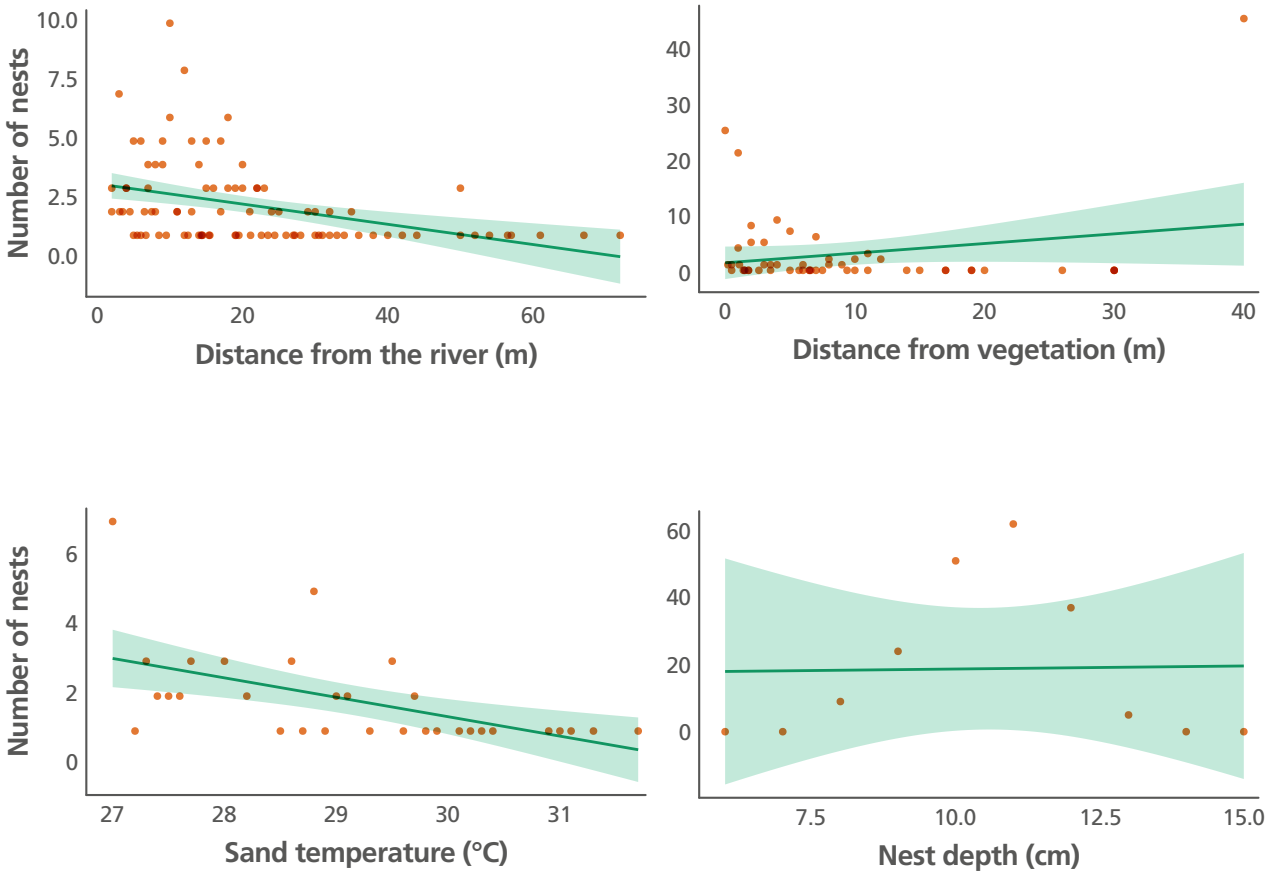
Table 5. Details of the complete model and the null model using the regression model to verify the influence of environmental characteristics on the number of nests; the he predictor variable showing a significant result is highlighted in bold

Response variable	Predictors	Estimate	Std. error	z value	Pr(>|z|)		$F_{1,16}$	R^2_{adj}	Model
Number of nests	**River distance (m)**	**-0.0429**	**0.0109**	**-3.94**	**1.62E-04**	***	F1,89: 15.52	0.1389	LM
Number of nests	Vege-tation distance (m)	0.1725	0.1142	1.511	1.37E-01		F1,51: 2.282	0.02406	LM
Number of nests	**Sand tempera-ture (°C)**	**-0.5562**	**0.1586**	**-3.508**	**0.001493**	***	F1,29: 12.31	0.2737	LM
Number of nests	Depth	0.1818	2.7411	0.066	0.949		F1,8: 0.0044	-0.1244	LM

Source: Braga-Pereira et al. 2023. CIFOR-ICRAF.

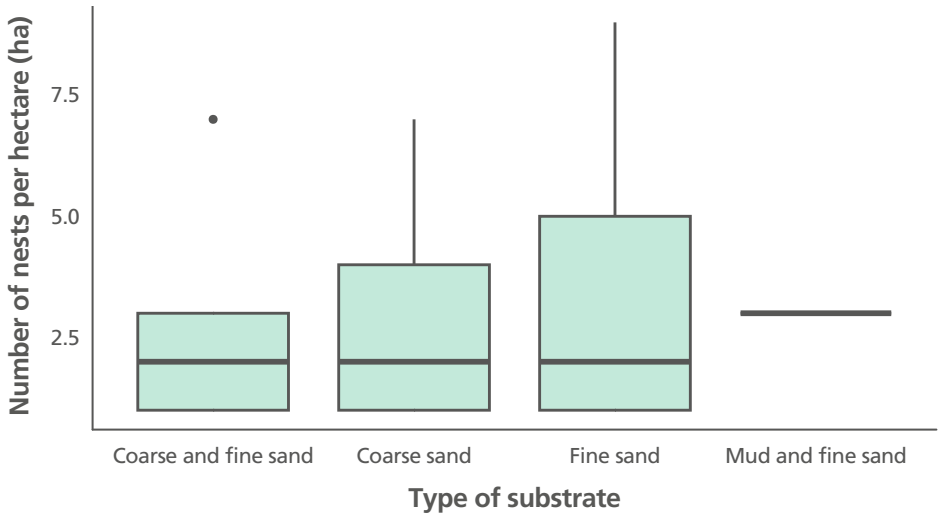
©Luke McKenna
Yellow-spotted river turtle waiting to be released at Yupukari Village turtle festival 2023

Figure 5. This illustrates the relationship between each environmental characteristic and the number of nests; the highlighted red box indicates a significant relationship between the analysed variable



Source: Braga-Pereira et al. 2023. CIFOR-ICRAF.

Figure 6: Number of nests per hectare per substrate



Source: Braga-Pereira et al. 2023. CIFOR-ICRAF.

Figure 7. A) Nest relocation to community hatcheries; B) hatching; C) hatchlings in their artificial pond; D) hatchlings being released into their natural habitat; E) nest being covered at the turtle hatchery; F) eggs collected from nests in flooded sites

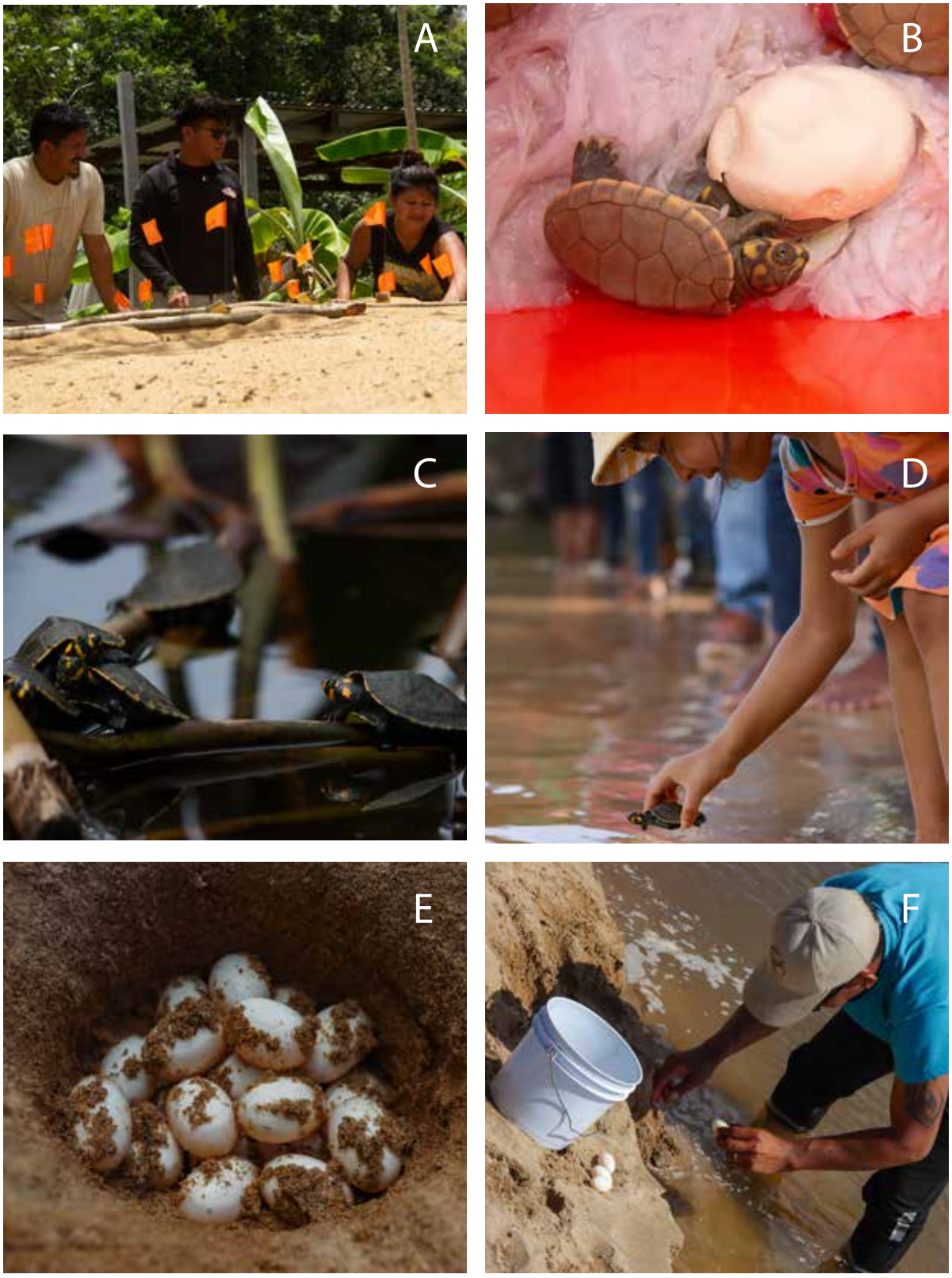


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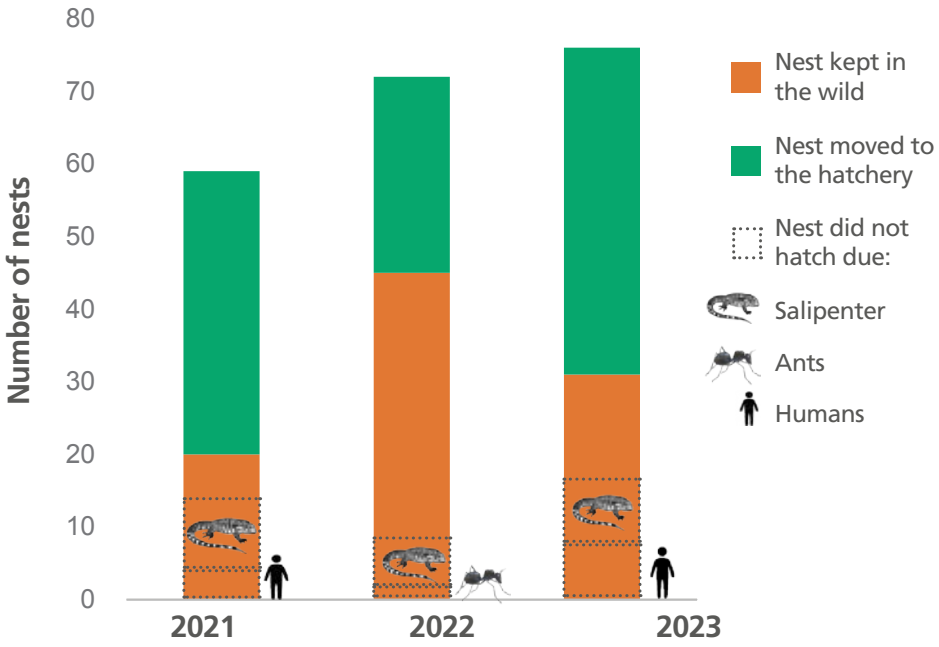
Figure 8. Number of nests kept and monitored in the wild, moved to a hatchery in the community, and destroyed over the three years of nest monitoring



Source: Braga-Pereira et al. 2023. CIFOR-ICRAF.

Table 6. Details of the complete model and the null model using a generalized linear mixed model to verify the influence of environmental characteristics on the nesting predation rate; the predictor variable showing a significant result is highlighted in bold

Response variable	Predictor variables	Estimate	Std. error	z value	Pr(>|z|)		Model	AIC	AIC null model	ΔAIC
Nesting predation	River distance (m)	0.1199	0.6562	0.183	0.8553		GLMM	167.56	194	33.29
	Vegetation distance (m)	**-1.1868**	**0.5545**	**-2.14**	**0.0336**	*				
	Substrate type (coarse: fine)	0.5532	0.5091	1.087	0.2785					
	Substrate type (coarse: fine/ coarse mix)	0.6699	0.609	1.1	0.2727					
	Substrate type (coarse: fine/mud mix)	0.8033	1.1247	0.714	0.476					
	Depth (cm)	0.178	0.1522	1.169	0.2438					

Source: Braga-Pereira et al. 2023. CIFOR-ICRAF.

Discussion

Among vertebrate taxa, freshwater turtles face some of the most severe threats (Lovich *et al.*, 2018; Gibbons *et al*., 2000). The Rupununi region, particularly the local communities of Yupukari and Caiman House, has taken pioneering steps in river turtle conservation in Guyana. This comprehensive programme encompasses both *in situ* and *ex situ* conservation efforts, with a strong focus on the vital egg and hatchling stages of development in multiple sand beaches in the northern part of the Rupununi. Over three consecutive years, we observed a small variation in nest numbers, with a small increase in 2022 and 2023 compared to 2021.

Our findings revealed an average of 6.68 nests per beach (SD = 3.66), indicating a density of approximately 14.2 nests per hectare (SD = 8.94). This density is markedly higher than what was recorded in the Orinoco River basin, where the average density was 0.05 nests per hectare (SD = 0.03) (Escalona and Fa, 1998), and in the Jurua River basin, which had an average density of 0.35 nests per hectare (SD = 0.42) (Campos-Silva *et al*., 2018).

Nesting success is closely linked to environmental factors, particularly the distance from the river and vegetation (Escalona and Fa, 1998; Ferreira Juniór and Castro, 2010; Pignati *et al*., 2013). Predation, flooding and human collection are major causes of nest loss, with the lizard species, *T. teguixin*, being the primary predator in our study area. Nest relocation has been essential to protect nests from flooding, although it raises concerns about potential negative effects on hatchlings such as alteration of sex ratios, reduced hatching, success, potential distortions in gene pools, and variations in carapacial scute patterns, sizes and weights (Mrosovsky, 2006; Türkozan and Yılmaz, 2007). However, with climate change threatening nesting sites, it remains the most practical option to enhance hatching success while carefully regulating temperature to maintain a balanced sex ratio.

Additionally, to address the aforementioned challenges, our programme emphasizes the selective collection of eggs from flood-prone regions, safeguarding both hatchling survival and ongoing conservation efforts. To further enhance our mitigation strategies, we carefully reposition collected eggs in plastic basins filled with beach sand to match the original nest depth, ensuring their successful development. Additionally, our hatcheries are meticulously designed to closely replicate a natural habitat, with dimensions measuring 6 m x 6 m and a height of 1 m, featuring precise temperature control within a range of 32 °C to 33 °C to maintain a balanced sex ratio.

Conclusions and recommendations

The conservation efforts in the Rupununi region have yielded significant results in protecting turtle nests and promoting successful hatching. However, it is imperative to continue monitoring and adapting conservation strategies as nest numbers fluctuate. To further enhance turtle conservation in this region, we recommend the following steps:

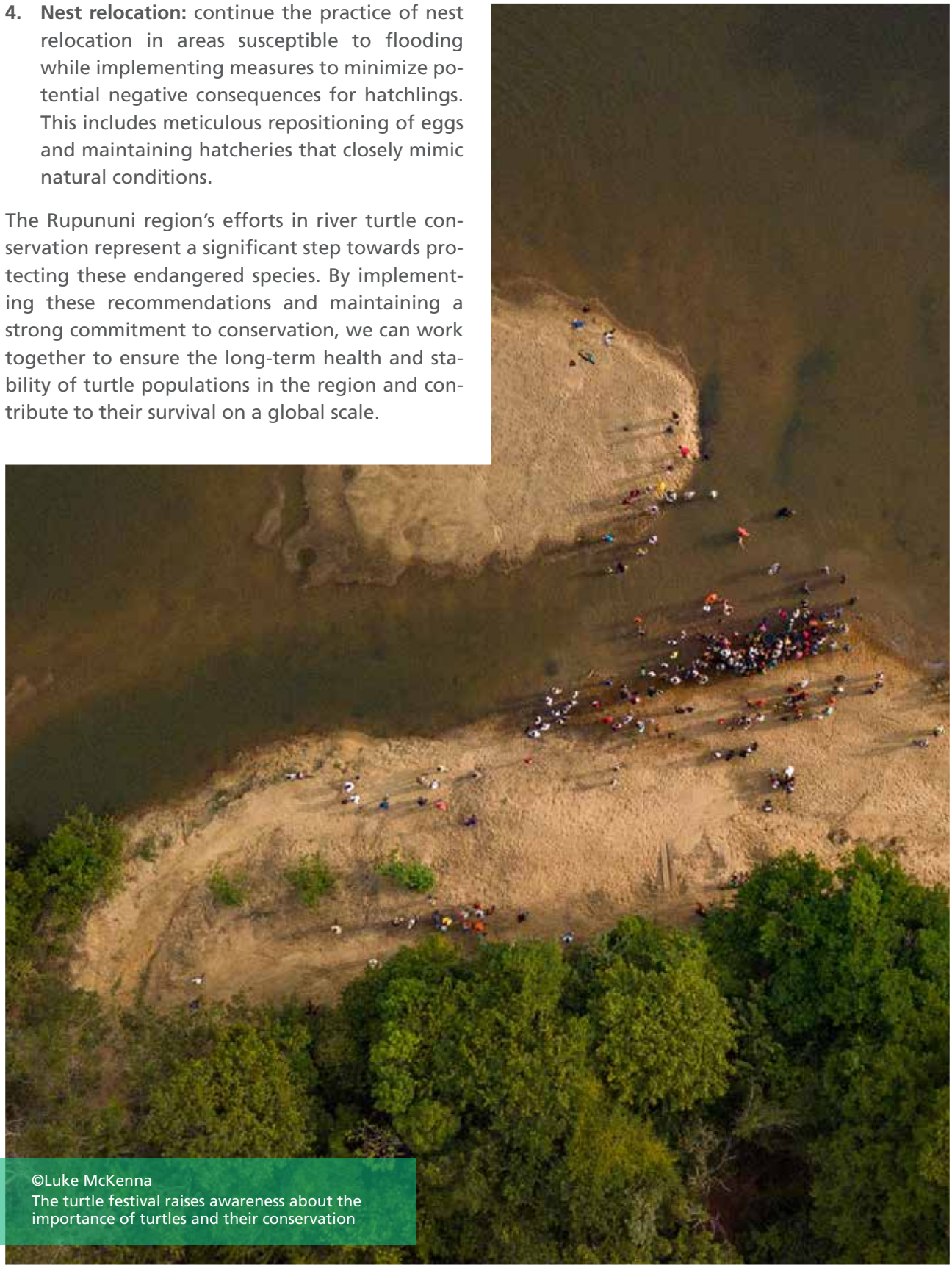
1. **Community engagement and advocacy:** encourage local communities, such as Yupukari and Caiman House, to raise awareness about turtle conservation. Collaborate with governmental agencies like the Protected Areas Commission and the Guyana Wildlife Conservation and Management Commission to involve them in turtle monitoring activities. Engaging the community and authorities is crucial for sustainable and effective conservation efforts.

2. **Long-term research and monitoring:** continue research and monitoring efforts to assess the impact of conservation practices, including nest relocation. This ongoing assessment is vital to ensuring that conservation initiatives are effectively safeguarding vulnerable turtle populations.

3. **Education and outreach:** continue with the educational programmes to inform the public about the importance of turtle conservation and the role people can play in protecting these species. Encourage responsible behaviour around nesting sites to reduce human interference.

4. **Nest relocation:** continue the practice of nest relocation in areas susceptible to flooding while implementing measures to minimize potential negative consequences for hatchlings. This includes meticulous repositioning of eggs and maintaining hatcheries that closely mimic natural conditions.

The Rupununi region's efforts in river turtle conservation represent a significant step towards protecting these endangered species. By implementing these recommendations and maintaining a strong commitment to conservation, we can work together to ensure the long-term health and stability of turtle populations in the region and contribute to their survival on a global scale.



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The turtle festival raises awareness about the importance of turtles and their conservation

References

Campos-Silva, J.V. *et al*. 2018. Unintended multispecies co-benefits of an Amazonian community-based conservation program. *Nature Sustainability,* 1(11): 650–656.

Conway-Gómez, K. 2007. Effects of Human Settlements on Abundance of *Podocnemis unifilis* and P. expansa Turtles in Northeastern Bolivia. *Chelonian Conservation and Biology*, 6(2): 199–205.

Eisemberg, C.C., *et al*. 2016. Vulnerability of giant South American turtle (*Podocnemis expansa*) nesting habitat to climate-change-induced alterations to fluvial cycles. *Tropical Conservation Science*, 9(4): 194008291666713.

El Bizri, H.R., Morcatty, T.Q., Valsecchi, J., Mayor, P., Vasconcelos Neto, C.F.A., Nijman, V. & Fa, J.E. 2020. Social and Biological Correlates of Turtle Nest Predation in the Brazilian Amazon. *Journal of Herpetology*, 54(2): 193–199.

Erickson, J., & Baccaro, F. 2016. Nest predation of the yellow-spotted amazon river turtle (*Podocnemis unifilis*. Troschel, 1848) by the fire ant (*Solenopsis geminata*, Fabricius, 1804) in the Brazilian Amazon. *Herpetological Journal* 26: 183–186.

Erickson, J., Farias, I.P. & Zuanon, J. 2020. The life history of the Yellow-spotted Amazon River Turtle (*Podocnemis unifilis*) as told from the nests. *Salamandra*, 56: 296–308.

Escalona T. & Fa J.E. 1998. Survival of nests of the terecay turtle (Podocnemis unifilis) in the Nichare-Tawadu Rivers, Venezuela. *Journal of Zoology*, 244: 303–312.

Fachín Terán, A. & von Mülhen, E.M. 2003. Reproducción de la Taricaya *Podocnemis unifilis* Troschel 1848 (Testudines: Podocnemididae) en la várzea del medio Solimões, Amazonas, Brasil. *Ecología Aplicada*, 2(1): 125–132.

Fagundes, C.K. *et al*. 2018. Vulnerability of turtles to deforestation in the Brazilian Amazon: Indicating priority areas for conservation. *Biological Conservation*, 226: 300–310.

Ferreira Júnior, P.D. & Castro, P. de T.A. 2010. Nesting ecology of *Podocnemis expansa* (Schweigger, 1812) and *Podocnemis unifilis* (Troschel, 1848) (Testudines, Podocnemididae) in the Javaés River, Brazil. *Brazilian Journal of Biology*, 70(1): 85–94.

Hernández, O. *et al*. 2010. Artificial incubation of yellow-headed sideneck turtle *Podocnemis unifilis* eggs to reduce losses to flooding and predation, Cojedes and Manapire Rivers, southern Venezuela. *Conservation Evidence*, 7: 100–105.

Kemenes, A. & Pezzuti, J.C. 2007. Population ecology and conservation of *Podocnemis sextuberculata* (Testudines, Podocnemididae) in the Javaés River, Araguaia basin, Brazil. *Chelonian Conservation and Biology*, 6(1): 82–90.

Mrosovsky, N. 2006. Distorting gene pools by conservation: Assessing the case of doomed turtle eggs. *Environmental Management* 38: 523–531.

Norris, D. *et al*. 2018. Freshwater turtle exploitation and conservation in Guyana. *Oryx*, 52(2): 260–267.

Norris, D. *et al*. 2019. Prospects for freshwater turtle population recovery are catalyzed by pan-Amazonian community-based management. *Biological Conservation,* 233: 51–60.

Oksanen, J., Guillaume Blanchet, F., Kindt, R., Legendre, P., Friendly, M., McGlinn, D., Minchin, P.R., O'Hara, R.B., Simpson, G.L., Solymos, P. *et al*. 2013. *Vegan: Community ecology package*, vol. 10: 631–637.

Paemelaere, E.A.D., David, O., & van Vliet, N. 2022. *Guyana–Legal, ecological and socio-economic baseline studies to inform sustainable wildlife management*. FAO, CIFOR-ICRAF, CIRAD, Wildlife Conservation Society (WCS); Rome, Italy. Retrieved from https://policycommons.net/artifacts/2677213/guyana/3700413/ on 05 Nov 2022. CID: 20.500.12592/5rc9vc.

Páez, V.P., *et al*. 2015. Population and genetic structure of the endangered Colombian river turtle *Podocnemis lewyana* (Testudines, Podocnemididae). *Amphibia-Reptilia*, 36(4): 417–429.

Pearse, D.E. 2006. Estimating population structure under nonequilibrium conditions in a conservation context: Continent-wide population genetics of the giant Amazon river turtle, Podocnemis expansa (Chelonia; Podocnemididae). *Molecular Ecology*, 15(4): 985–1006.

Peñaloza, C.L., & Vogt, R.C. 2013. Management and Conservation of *Podocnemis unifilis* and *P. expansa* (Testudines, Podocnemididae) in Orinoco, Venezuela. *Chelonian Conservation and Biology,* 12(1): 199–204.

Pignati, M.T., Fernandes, L.F., Miorando, P.S., Ferreira, P.D. & Pezzuti, J.B. 2013. Nesting Site and Hatching Success of *Podocnemis unifilis* (Testudines: Podocnemididae) in a Floodplain Area in Lower Amazon River, Pará, Brazil. *South American Journal of Herpetology,* 8(3): 175–185. doi:10.2994/sajh-d-13-00006.1

Ponce de Leão, S. *et al*. 2019. Home Range of Yellow-Spotted Amazon River Turtles (*Podocnemis unifilis*) in the Trombetas River Biological Reserve, Pará, Brazil. *Chelonian Conservation and Biology*, 18(1): 10–18.

R Development Core Team. 2019. *R: A language and environment for statistical computing*. R Foundation for Statistical Computing.

Rachmansah, A. *et al*. 2020. Impact of Urbanization and Agricultural Activities on Freshwater Turtle Populations in Central Java, Indonesia. *Herpetological Conservation and Biology,* 15(3): 554–568.

Rhodin, A.G.J. *et al*. 2018. Global Conservation Status of Turtles and Trends in Their Extinction Risk. *Conservation Biology*, 32(1): 40–49.

Türkozan, O., & Yilmaz, C. 2007. Nest relocation as a conservation strategy: Looking from a different perspective. *Marine Turtle Newsletter,* 18: 6–8.

1.3. Fish stocks in the North Rupununi

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Highlights

- Inland fisheries are important for food security in communities across the North Rupununi. However, the state of exploited stocks is poorly understood due to limited data and assessment.
- Monitoring fish stocks in such a heterogeneous landscape is complex and resource intensive. This situation highlights opportunities for community-based monitoring (CBM) to support data-limited assessments.
- Standardized CBM was established for the North Rupununi as part of a new inland fisheries management plan initiated by Indigenous community groups with support from local and national government.
- Quantitative length-based assessments were undertaken for selected target stocks; findings suggest moderate levels of exploitation consistent with local perception.
- Our study highlights the finding that local experts and community participants with different levels of training can collect accurate biodiversity data.
- It is important to continue and develop CBM in the North Rupununi, potentially using local ecological knowledge to track spatial and temporal patterns in exploitation and stock status.

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NRDDB ranger conducting a fish stock assessment

Introduction

Fish are a crucial protein source among Indigenous Peoples in the Rupununi, representing 60 percent of animal protein in the diet of Makushi communities (Luzar *et al*., 2012) and contributing to the primary income for 29 percent of households (Henfrey, 2002). Out of a total of 343 fish species recorded in the Rupununi drainage (de Souza *et al.,* 2012), between 70 and 100 species (groups) are consumed by the Makushi (Conservation International, 2002; Conservation International Guyana and IDB, 2015).

Given the importance of freshwater fish for the local Rupununi economy, managing freshwater fisheries sustainably is important for both food security and bending the curve of biodiversity loss. Yet, most communities in North Rupununi report that fish populations have declined. Decreasing catches, the need to travel further to be successful and a change in species caught are all signs pointing to the decline of fish populations. These perceptions are further confirmed by empirical evidence on the size of fish caught, with large individuals now less common in fish surveys, indicating high fishing pressure (Ingwall-King, 2013). The decrease in fish size leads to a greater demand for catching a larger quantity of smaller fish to meet protein requirements. Since the 2013 publication by Ingwall-King, the decline in fish populations has been exacerbated by drought and intensified commercial fishing activities. Many fishermen have reported significant difficulty in catching fish, providing additional evidence for this trend (Panthera Guyana, 2015). A study conducted a decade earlier by Mistry *et al.* (2004) did not observe an immediate impact on fish populations, although during the same period villagers reported having to venture further to fish, and observed changes in fish availability, including concern over various species (Conservation International, 2002).

In this context, fish stock assessment is an important tool, allowing managers to take proactive measures rather than reactive ones, to determine appropriate management procedures, such as setting catch regulations, and to initiate enhance-

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Yupukari village fisher catches fish for his family as the sun goes down

ment or restoration measures, even in data-limited systems. However, formal state assessment is relatively uncommon in inland fisheries systems (Fitzgerald *et al*., 2018) due to the dispersed and heterogeneous patterns of exploitation, sales and consumption that make collecting representative data challenging. Furthermore, many inland systems, such as floodplain rivers, exhibit strong seasonal fluctuations in the relative abundance of different fish species and life history stages, resulting in shifts in exploitation patterns.

Stock assessments in commercial marine fisheries often rely on catch or landings records when other information is not available. However, this approach is problematic in complex inland fisheries with diverse users and many small landing sites, where catch data may not accurately represent the true extent of fishery removals. Assessment methods based on fish population size distributions, such as length records, can be more informative in such systems (Pons *et al*., 2020) and require less frequent monitoring. Length-based stock assessment assumes that size-selective fishing removes larger individuals and species), leading to predictably curtailed fish population size distributions in exploited systems. Empirical length-based indicators (LBIs) can be used by comparing summary statistics for observed length distributions to appropriate good state reference points (ICES, 2015) or may act as trends-based surveillance indicators. The basic principle of length-based models (LBMs) is that observed lengths can be compared to a theoretical 'expected' population size distribution characterized from life history theory for an unexploited situation. The difference between observed and expected length distributions thus expresses fishing pressure and fishing gear size selection. There are some informative examples of LBMs being used in inland systems, e.g. the length-based spawning potential ratio (LB-SPR) (Hordyk *et al*., 2015a) model in the Brazilian Amazon (Shephard *et al*., 2021a) and the length-based Bayesian biomass (LBB) model in Lake Edward, East Africa (Musinguzi *et al*., 2021).

Appropriate data for length-based assessments can be obtained by sampling commercial landings or from fisheries-independent surveys (Shephard *et al*., 2021a), and do not need to measure overall removals from a target stock. However, collecting representative data across extensive, complex and poorly resourced inland fisheries, where local knowledge is paramount, can be challenging for external researchers (Valbo-Jørgensen and Poulsen, 2000). It is much more productive to work with local people who know the system intimately. In this chapter, we present (i) the development

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A Makushi family shares boily fish and farine freshly caught from the river

of a standardized community-based monitoring (CBM) protocol for target fish stocks in the North Rupununi, and (ii) quantitative length-based assessments for key target species with a spawning potential ratio (SPR) state indicator calculated for selected stocks using the LB-SPR model (Hordyk *et al*., 2015a). We discuss the role of CBM in supporting assessment and management of data-limited fisheries across the Rupununi freshwater systems.

Methods

Study area and governance context

North Rupununi has a network of ponds and waterways, including large rivers that flood extensive areas of wetland during the rainy season. Local communities in this district heavily rely on these wetland resources for their subsistence activities (Mistry *et al*., 2008). Despite the social and economic importance of this sector, inland fisheries in Guyana remain unregulated under national law, and mostly have no institutional management. Although traditional management and enforcement structures still exist in some communities connected to the North Rupununi District Development Board (NRDDB), these regulations are insufficient to maintain sustainable exploitation as systems become more accessible, particularly in areas close to roads and logging developments. A key problem is the wider use of efficient modern gear, such as monofilament gillnets, and enhanced capacity to transport fresh fish to external markets.

This fluid situation is common in the neighbouring Amazon regions, and efforts have been made to leverage traditional community-based management (Lopes *et al*., 2018) that relies on social memory (Mistry *et al*., 2014). In 2011, a first significant attempt was made to develop a bottom-up inland fisheries management plan in Guyana in association with a previous international development project. Makushi community members proposed the establishment of fishing licences and a catch-recording programme for all types of fishing activity. However, the communities quickly realized that licensing and reporting would be too burdensome for subsistence fishers, while peer enforcement also seemed unfeasible. As a result, the 2011 management process faltered.

In 2018, with support from the Sustainable Wildlife Management (SWM) Programme, a new work plan was developed for implementing the fisheries management plan, with a focus on monitoring and awareness raising. The work conducted by NRDDB, in collaboration with village councils, raised increased interest at the governmental level, as the National Fisheries Department prepared to develop their inland fisheries regulations and strategic plan. In 2022, the need intensified to revise the fisheries management plan to better specify responsibilities between the village council, NRDDB and the Fisheries Department in the co-management structure, and to ensure this harmonized with the fisheries regulations under development. In addition, an economic analysis of the fishery value chain was initiated to explore possibilities for internal funding, with the ambition to reduce dependency on external project funding for the implementation of the fisheries management plan.

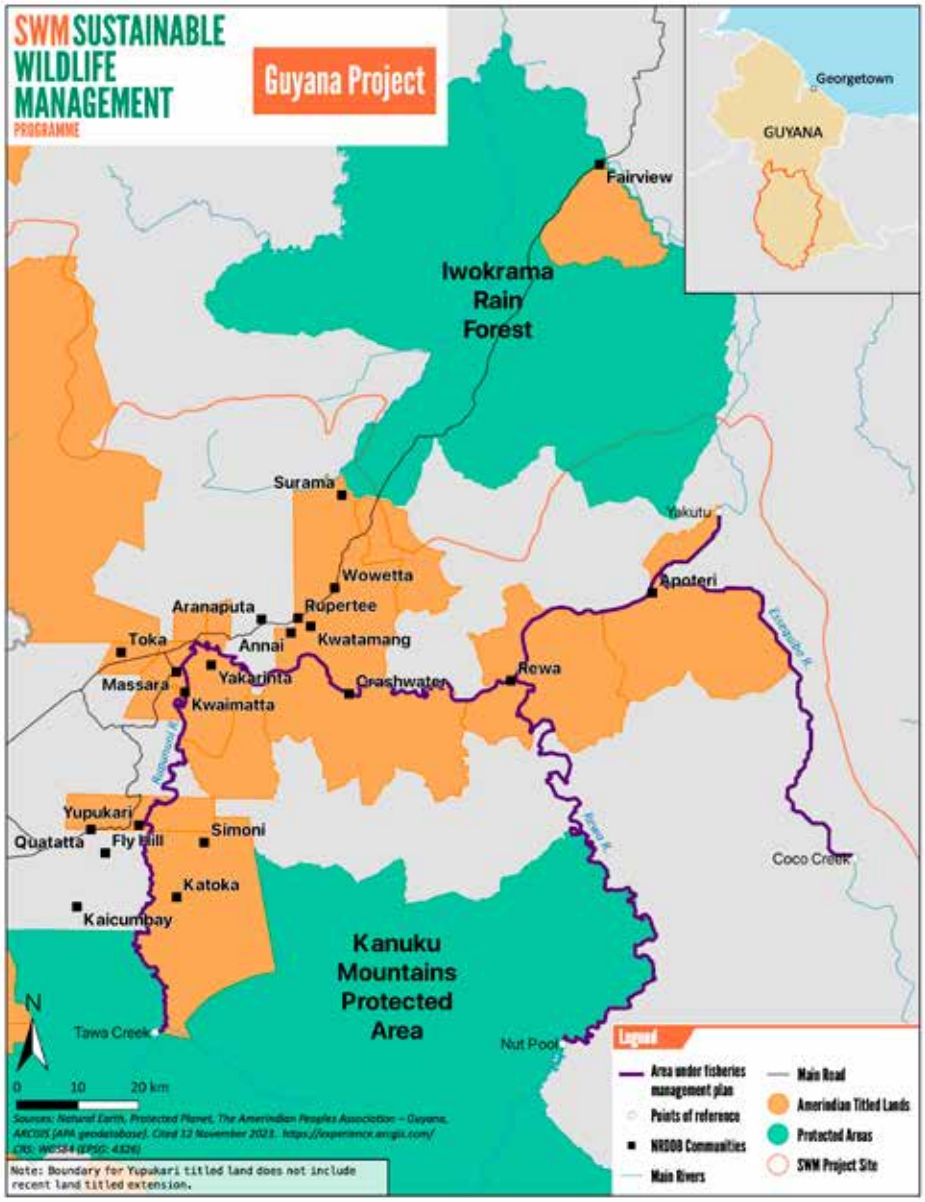
Fish monitoring surveys

The NRDDB's new fisheries monitoring programme was the first of its kind in Guyana and involved close coordination with 20 member communities in the North Rupununi and with the Guyana Department of Fisheries. Its objective was to develop a standardized CBM programme for fish, with a focus on providing data to support quantitative assessments of key target stocks. Given that such a programme can be both expensive and time-consuming, the aim was to evaluate the current stock status and establish baselines for subsequent semi-quantitative monitoring based on local ecological knowledge (LEK). The programme placed great emphasis on involvement of local fishers and their knowledge of the Rupununi social-ecological system.

NRDDB conducted standardized fish monitoring surveys in May 2021, as river levels rose at the onset of the rainy season, and in both October and November 2020 and 2021, as river levels receded at the onset of the dry season. These survey periods

were selected to capture information related to fish spawning and recruitment, and were informed by community LEK. Upcoming surveys were advertised on community radio, and village leaders were asked to nominate two fishers to work with the team in their local areas. Community researchers from six villages were involved in the surveys. They were not typically paid, but contributed as a community endeavour, with a total of 26 people being trained in fish monitoring methods and participating in the first two surveys. The local insight of these fishers proved extremely useful in fish identification as well as in the optimal use of local fishing gear and selection of appropriate fishing sites in the North Rupununi region. Most survey sites were well known to village councils as good fishing locations and/or were familiar to the regional researchers from previous fisheries patrols.

Figure 9. Map of the NRDDB fisheries management area, stretching across 20 Indigenous communities around the Rupununi, Rewa and Essequibo rivers



The boundaries and names shown and the designations used on this/these map(s) do not imply the expression of any opinion whatsoever on the part of FAO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers and boundaries. Dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

The same sites were sampled across all three survey periods, but the CBM strategy was allowed to be highly adaptive in order to meet local understanding and needs. Standard scientific gillnets were the main survey gear used in 2020, while a set of local gears were preferred for both surveys in 2021. This change in type of gear was intended to catch larger fish and to match the survey more closely with corresponding subsistence and artisanal fisheries. The local gears were fished according to common practice as understood from LEK, such as using handlines for peacock bass (*Cichla ocellaris)* in the morning, and cadel (mid-water longlines) in the afternoon and at deeper water sites targeting catfish, for example. Fishing gear, sites, and time were recorded for each survey 'haul' (fishing event). Each fish caught was identified to species where possible and its length and weight measured. The survey data provided a size distribution (numbers at length, in cm) for each of the more abundant sampled fish species, potentially supporting length-based stock assessment approaches.

Development and implementation of the monitoring programme was a community-led process. Local knowledge and experience were used constantly to evaluate and modify the survey to better represent the habitats and fish populations targeted by local fishers. This iterative process produced recommendations for future surveys, including understanding and insights that may be useful to other community groups initiating similar programmes elsewhere.

Fish stock assessments

Observed contrasts in season and gear over the surveys, as well as some extreme weather conditions, were considered by local researchers to have influenced the species and size distributions of the catch. Hence, the three survey datasets were considered separately for assessment of fish population state. Only a few marketable species had more than 50 individuals in either year (see Table 7). Simulations by Hordyk *et al*. (2015a) previously showed that model estimates of SPR became more

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Measuring the length of a dawalu during an NRDDB fish stock assessment

uncertain as sample size was reduced progressively to 100 individuals, but due to small sample sizes in the NRDDB surveys, we attempted to apply length-based assessment methods to any commercially important species with at least 50 individual length records (see Table 7).

Table 7. Number of individuals (N) of the most abundant target fish species (N > 50) in each NRDDB fish monitoring survey

Number of individuals				
Species	**Common name**	**Oct-20**	**May-21**	**Nov-21**
Ageneiosus inermis	Dawalu	216	54	220
Ageneiosus ucayalensis	Duck catfish	n/a	195	n/a
Boulengerella Cuvieri	Swordfish	n/a	n/a	88
Cichla ocellaris	Peacock bass	55	n/a	169
Hydrolycus armatus	Black-tail biara	281	53	123
Hydrolycus tatauaia	Characin	82	n/a	n/a
Piaractus brachypomus	Red pacu	n/a	59	n/a
Pygocentrus nattereri	Red piranha	354	n/a	186

Source: Shephard, S. et al. 2023.

A reliable LBI ($L_{max5\%}$, ICES, 2015) was first estimated for each of these more abundant species. The $L_{max5\%}$ indicator requires an input estimate of Von Bertalanffy L_∞ (theoretical mean maximum length); the indicator is calculated as the mean length of the largest five percent of fish in the survey population/L_∞. This ratio expresses the abundance of measured individuals having body size close to the terminal length. A proposed threshold for good state is $L_{max5\%} > 0.80$ (ICES, 2015), although this varies with exploitation pattern and fish life history.

Estimates of spawning potential ratio (SPR) for the selected North Rupununi fish stocks were then obtained using the LB-SPR model (Hordyk *et al.*, 2015a). SPR is the lifetime reproductive output per recruit of a fished population divided by the corresponding output per recruit if the population had never been fished. It thus expresses how fishery removal of sexually mature individuals impairs overall productivity, e.g. spawning stock biomass. The LB-SPR model estimates values of relative fishing mortality (F/M) and selectivity-at-length (fishing gear selection pattern) that minimize the difference between observed (fitted catch) and expected (modelled from life history) length distributions. It then calculates the resulting SPR, which can be compared to a value representing good state, although this threshold may vary with fish life history e.g. SPR = 0.20 to 0.40.

The expected length distribution is derived in LB-SPR using input estimates of L_∞ and M/k, while SPR is calculated using input estimates of the mean lengths at which 50 percent (L_{m50}) and 95 percent (L_{m95}) of a given population become sexually mature, to specify which component of the population size distribution is likely to contribute to recruitment of juveniles. LB-SPR thus uses L_∞ as an input, and further requires values for Von Bertalanffy k, natural mortality M, L_{m50} and L_{m95} for a given population. Estimates of these life history parameters (LHP) should ideally be derived for the specific population being assessed (Fitzgerald *et al.*, 2023). However, this process is frequently impractical for data-limited populations, and so general estimators or statistical approaches can be used. Values may also be taken from similar or proximate populations of the same fish species (Shephard *et al.*, 2021a). There is a risk in both approaches to obtaining proxy LHP, because parameters such as L_∞ and M/k can differ considerably among populations and are strongly influential in LB-SPR, possibly inducing misleading estimates of ecological state.

A literature search was used here to find LHP values (L_∞, k, L_{m50} and L_{m95}) for each study species that seemed appropriate for the North Rupununi survey stocks to be assessed (see Table 8). These values were then used to derive a composite (mean) estimate of M for each assessed species (see Table 8) using methods collected by Cope and Hamel (2022), to be used as the input to LB-SPR. Asymptotic length L_∞ tends to be the LHP that most in-

fluences estimates of SPR, because it constrains the expected number of large fish. To explore the sensitivity of outcomes to error in this parameter, LB-SPR estimates of SPR were derived for selected North Rupununi fishes using inputs of each of L_{∞} (the literature estimate), $L_{\infty + 5\%}$ and $L_{\infty - 5\%}$.

The estimate of selectivity-at-length in the original LB-SPR model (Hordyk *et al*., 2015a) assumes that the dominant gear used in the fishery shows asymptotic (trawl-type) size selection, i.e. all individual fish larger than some size are retained. Dome-shaped selection may be more likely for the NRDDB survey gears (gillnets and hooks), in which some larger individuals are probably not retained, e.g. by a smaller hook or static gear mesh sizes. The dome-shaped form can be implemented in LB-SPR (Hommik *et al.*, 2020), but this format requires input gear selectivity parameters which were not available for the current assessed species, and so asymptotic selection was assumed as a conservative approach (Hordyk *et al.*, 2015b).

The LB-SPR model can be implemented using an R package (Hordyk, 2019) or an online app (Length-Based SPR - The Barefoot Ecologist's Toolbox). A new (currently unpublished) app recently developed at Inland Fisheries Ireland (IFI) has extended the model to include estimates of uncertainty (95 percent confidence intervals) for SPR (https://github.com/colmjfitzgerald/GTG-LBSPR_Dome-Shaped). The new app estimates confidence intervals for SPR, and also provides output plots that describe model fit and compare observed and expected size distributions of the assessed fish population, as well as diagnostic plots expressing whether key model assumptions are likely to have been violated, and consequently, whether the results can be considered reliable. The current assessments were undertaken using the IFI app, but point estimates of SPR are expected to be the same using one of the other available LB-SPR tools.

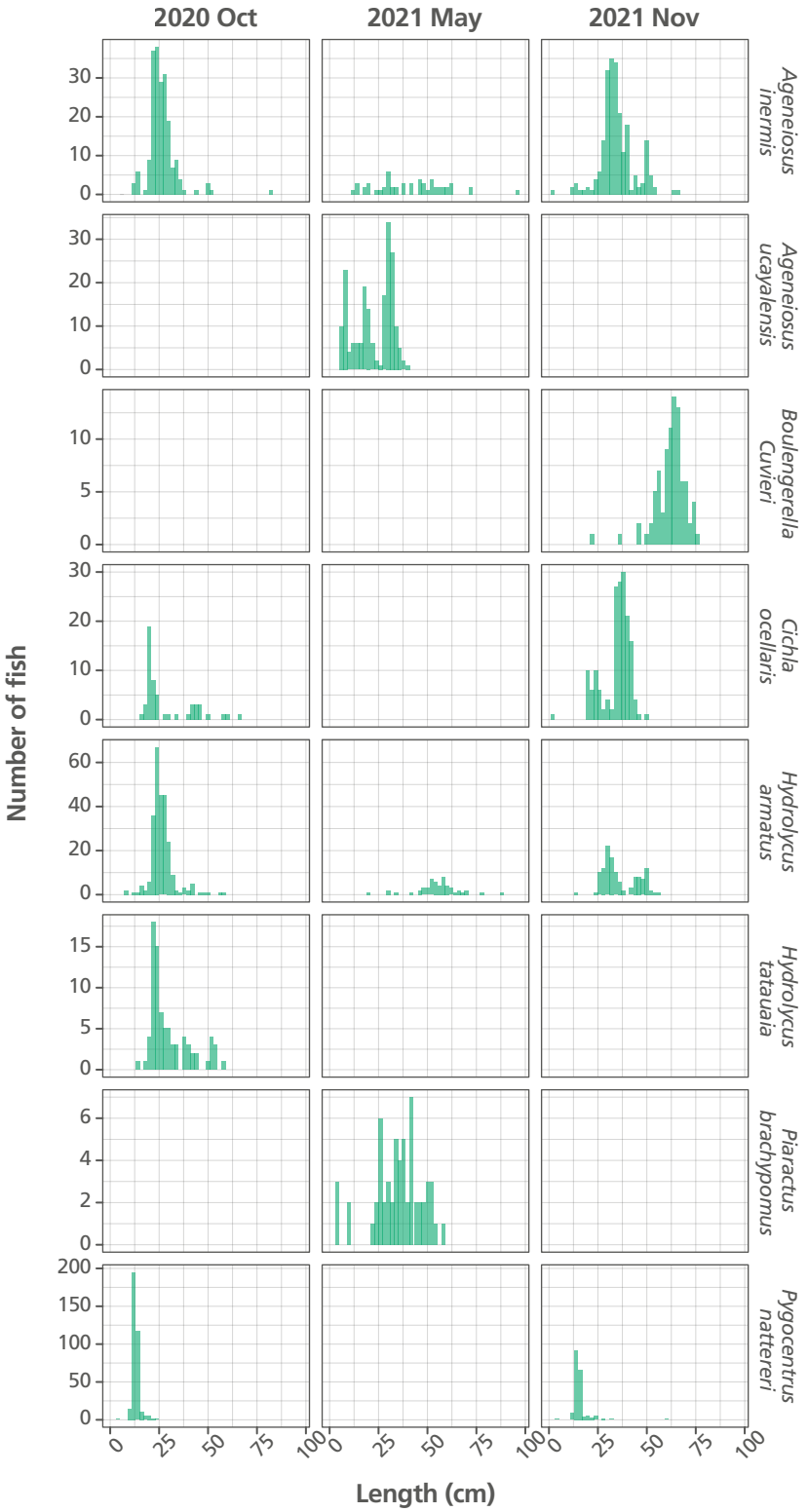
Table 8. Life history parameter estimates used for assessment

Species	L_{∞}	k	L_{m50}	L_{m95}	A_{mat}	A_{max}	M	References
Pygocentrus nattereri	23.6	0.67	12	15	1	7	1.37	Duponchelle *et al.* (2007)
Ageneiosus inermis	73.7	0.25	35	45	n/a	9	0.52	Camargo *et al.* (2015); Sa-Oliveira *et al*. (2015)
Cichla ocellaris	83.0	0.18	25	30	2	n/a	0.64	Holley *et al*. (2008); Jepsen *et al.* (1999)
Hydrolycus armatus	85.0	0.15	35	50	n/a	11	0.38	Camargo *et al.* (2015). Reference L_{∞}= 93.7
Hydrolycus tatauaia	85.0	0.15	35	50	n/a	11	0.38	Camargo *et al*. (2015). Reference L_{∞}= 93.7
Boulengerella cuvieri	78.0	0.36	40	50	n/a	n/a	0.61	Mendes *et al.* (2017); Fonseca (2021); Camargo *et al.* (2015)
Ageneiosus ucayalensis	38.0	0.54	15	21	2	n/a	0.89	Camargo *et al*. (2015); Oliveira *et al*. (2017); Ref L_{∞}= 33.7
Piaractus brachypomus	64.0	0.60	30	45	7	28	0.47	Guerreiro *et al.* (2018); Loubens and Panfili (2001)

Source: Shephard, S. et al. 2023.

Note: L_{∞} and k are from the Von Bertalanffy growth equation, L_{m50} and L_{m95} are the lengths at 50 percent and 95 percent maturity respectively, A_{mat} is age at maturity, A_{max} is longevity (y), and M is mean natural mortality from a set of published estimators

Figure 10. Size distribution of the assessed target fish (see Table 7) caught in each survey season



Source: Shephard, S. et al. 2023.

Results

Fish monitoring surveys

Considerable species richness was evident in both surveys, with around 100 fish species recorded in 2020 and 50 in 2021. The most abundant species of fishery importance varied among sampling periods (see Table 7). The NRDDB monitoring surveys generally caught fewer fish in the upper Rupununi than in the upper Rewa and Essequibo catchments. Survey catches (species composition and population size distributions) also differed strongly between survey seasons and years. The May and November 2021 data represented a more multimodal size distribution than observed in October 2020, and included larger individuals of several species (see Figure 10). However, changes made in gear type and survey season mean that data from 2020 and 2021 cannot readily be compared. Most fish recorded in the 2020 survey were taken in standard scientific gillnets, while the 2021 surveys emphasized a set of local gears, including cadel and handlines. Community experts considered that observed shifts in catch predominantly reflected differences in size- and species-selectivity between survey gillnets and the artisanal/commercial fishing gears. The gillnets had smaller mesh and were set close to the surface where smaller fish are expected. There may also be seasonal effects related to fish growth and recruitment, e.g. greater abundance of small juvenile fish in May or of larger migrating fish in October–November.

Community discussion throughout the survey development process highlighted important issues and led to some decisions about the future of the survey. The first requirement identified was to change the annual monitoring period. Surveys conducted as river levels recede are the preferred option, with the apparent advantages of catching more large fish and of considerably easier access to sample sites due to dry season conditions. This season is also the period that fishers look forward to each year as benthic-feeding fish are in prime condition following foraging in the flooded landscape (Oliveira *et al*., 2006). However, it should be recognized that different seasons and water conditions may support different fishers and livelihoods, and the protocol should be open to other local voices. Secondly, it was recognized that the survey gear had to be standardized. The local fishing gears used to survey in 2021 seem to be more informative for monitoring the North Rupununi fish community. Using commercial gear for surveys also has advantages for size-based stock assessment, because the survey selection pattern (size and species) is expected to match that of the gear imposing most fishing pressure. This correspondence simplifies estimates of size-selective fishing mortality for given assessed species using LB-SPR. More technical decisions discussed among community researchers referred to standardizing fishing effort for each survey site and gear type; selected fishing gears have so far been used according to local knowledge, e.g. site characteristics or time of day. The number of fishing events for each gear type (e.g. number of cadel lines, number of handline fishers, etc.) should now be fixed for each site.

The NRDDB recognizes that maintaining their fish monitoring in the future will require a reduced survey programme that can be implemented sustainably with only local and national funding. Available resources mean that sites may have to be surveyed quantitatively at multiyear intervals, interspersed with monitoring perceived trends based on LEK. Community researchers proposed that a streamlined survey could exclude the Essequibo River and concentrate on the more populated Rupununi and Simoni systems. One suggested approach was to identify key 'sentinel' sites that are expected to have relatively low or high fishing pressure, and which should be surveyed more frequently. Rewa is considered to have a strong conservation ethic, while Apoteri is relatively isolated and hence, is sheltered from intense fishing. There are other regions where overfishing is a concern; for example, the Essequibo River and tributaries between Kurupukari and Rockstone (outside of the NRDDB fisheries management area) experience hunting and fishing pressure in support of mining and logging industries. The nutrient classification of different systems; for example, whitewater versus blackwater rivers could also be considered.

Fish stock assessments

An estimate of the empirical $L_{max5\%}$ indicator and SPR (from LB-SPR) was derived for each tested fish species. These species represent a range of different life history types and maximum sizes, and hence have potential as indicators of ecological state for the broader fish community. The LBI suggested moderate to good state for all species, while SPR from the LBM was much more variable (see Table 9). Model fit was generally acceptable for LB-SPR, with diagnostic plots not suggesting strong reasons for rejecting the results. An exception was *Ageneiosus inermis* in May 2021, where the assessment showed wide confidence intervals and an unreliable outcome, probably reflecting the small sample size (see Table 7). Assessment outputs for this case are not shown (see Table 9). For other species, assessments tended to show a better state for 2021 than 2020, except for *Cichla ocellaris* (see Table 9). The simple sensitivity analysis indicated that a ±five percent error in input L_{∞} could strongly influence the model estimate of SPR, with implications for reliably inferring fish population state (see Table 9).

The contrast in survey catches across years was exemplified for *H. armatus*, which was the only species sufficiently abundant to be assessed in all three surveys. State from SPR for this population was assessed as poor (less than 0.2) from the October 2020 data; good (more than 0.4) from the May 2021 data; and moderate (0.2–0.4) for November 2021 (see Table 9). This outcome reflects marked differences in observed size distribution between surveys, with larger fish (assumed to indicate better state) being much more evident in the local fishing gears used in 2021 (see Figure 10). As expected, estimates of SPR were generally larger when the input value of L_{∞} was smaller (see Table 9), highlighting potential for bias if input LHP estimates taken from other stocks do not match the growth schedule of the assessed stock.

Discussion

Local social-ecological initiatives are extremely important to sustainable management of inland fisheries. Typically, it is beneficial to apply the knowledge and skill of fishers in resource monitor-

Table 9. Estimates of the empirical $L_{max5\%}$ indicator, and fishing mortality F and spawning potential ratio (SPR) from the LB-SPR model

Sample	Species	$L_{max5\%}$	MLS	F	SPR	SPR $L_{\infty+5\%}$	SPR $L_{\infty-5\%}$	State
Oct-20	***Pygocentrus nattereri***	0.83	10	3.1	**0.217**	0.178	0.268	poor-moderate
Oct-20	***Hydrolycus armatus***	0.54	20	1.41	**0.023**	0.018	0.028	poor
Oct-20	***Ageneiosus inermis***	0.64	20	1.33	**0.038**	0.030	0.057	poor
Oct-20	***Hydrolycus tatauaia***	0.57	20	0.42	**0.156**	0.127	0.197	poor
Oct-20	***Cichla ocellaris***	0.74	20	0.24	**0.487**	0.361	0.536	good
May-21	***Ageneiosus ucayalensis***	1.13	25	1.04	**0.751**	0.640	n/a	good
May-21	***Piaractus brachypomus***	0.86	20	0.65	**0.214**	0.164	0.282	poor-moderate
May-21	***Ageneiosus inermis***	1.09	20	n/a	**n/a**	n/a	n/a	n/a
May-21	***Hydrolycus armatus***	0.93	20	0.207	**0.716**	0.612	0.850	good
Nov-21	***Pygocentrus nattereri***	1.19	10	1.13	**0.515**	0.425	0.640	good
Nov-21	***Boulengerella Cuvieri***	0.96	n/a	1.44	**0.679**	0.581	0.797	good
Nov-21	***Ageneiosus inermis***	0.72	20	0.72	**0.185**	0.149	0.234	poor-moderate
Nov-21	***Hydrolycus armatus***	0.61	20	0.31	**0.273**	0.223	0.339	moderate
Nov-21	***Cichla ocellaris***	0.54	20	10.5	**0.263**	0.228	0.305	moderate

Source: Shephard, S. et al. 2023.

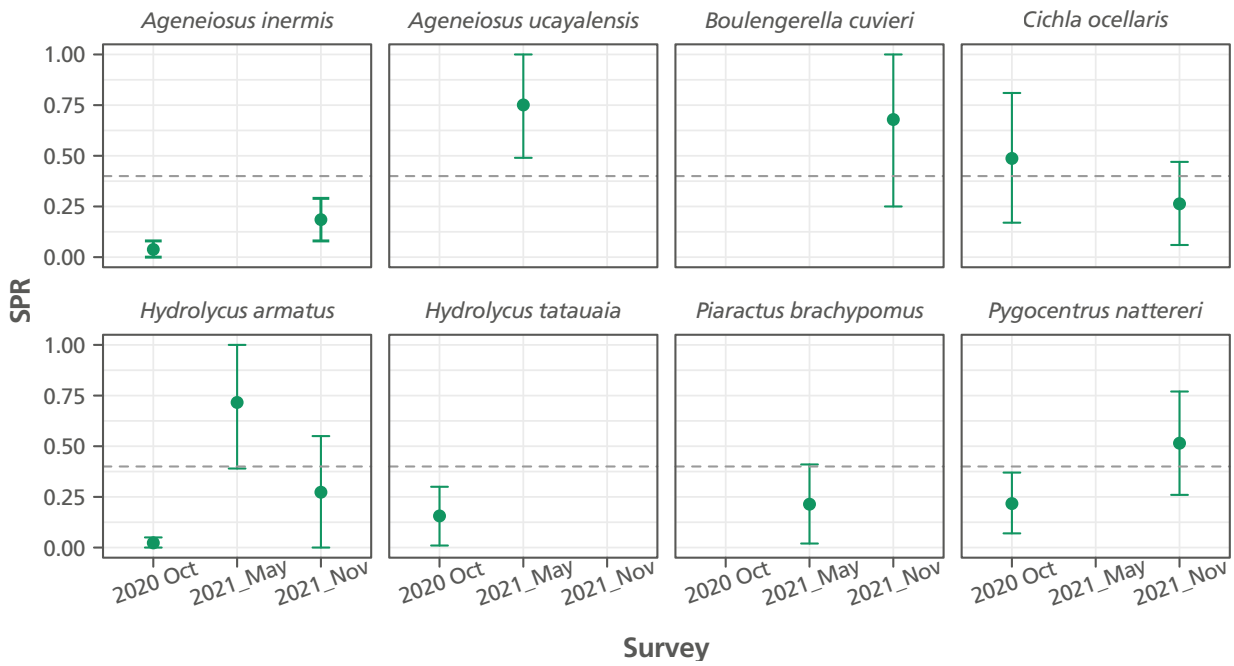
Note: MLS is a minimum landing size and excludes smaller fish from the analysis. State is considered 'good' at $L_{max5\%} > 0.8$ and/or SPR > 0.40.

ing and management, and to bridge knowledge systems across stakeholders. The NRDDB pilot programme is a collaboration between local communities, multidisciplinary scientists and the national government. It has successfully established a standardized fish monitoring survey for the North Rupununi, testing several available sampling gears and targeting a wide range of sites. The survey seems to be effective, catching most of the more abundant fish species and including those important to local fisheries and livelihoods. These quantitative data provide a baseline for the fishery state, with scope for future application of accessible trends-based indicators based on LEK.

Survey length distributions were used here to derive an empirical and a model-based state metric for each of eight more abundant North Rupununi fish species of fishery interest. These baseline assessments provide scope to draw conclusions about the impact of fisheries in the region, and to track future change using LEK and periodic quantitative updates. Length-based methods are not expected to capture higher-level ecosystem pressures, such as pollution and climate change, and so broader monitoring of ecological state will also be necessary.

Uncertainty in input life-history parameters and relatively small sample sizes (less than 100 individuals for some stocks) mean that we cannot comment conclusively on the state of the North Rupununi fish community. The very poor population state suggested by the model fits to the 2020 data (see Table 9; and Figure 11), and probably reflects selection for smaller individuals in the scientific gillnets used in that initial survey. The 2021 data include more frequent larger individuals and estimated state is correspondingly more positive. It is not yet possible to characterize selectivity in the local fishing gears, or to quantitatively evaluate the current assumption of asymptotic selectivity. A more important limitation is lack of life-history parameters estimated directly from the fish stocks studied; input values for L_∞, k and M were derived here from published esti-

Figure 11. Estimates of spawning potential ratio (SPR)



Source: Shephard, S. et al. 2023

Note: SPR with 95 percent confidence intervals for the more abundant commercial species caught in the North Rupununi fish monitoring survey. The dashed line shows a candidate good state reference point at SPR = 0.4 (Table 9). The survey in 2020 used standardized gillnets, while both surveys in 2021 used a set of local gears.

mates for similar populations. This necessity could bias assessment outcomes, since inappropriately high L_∞ values will result in underestimation of SPR because the LB-SPR model will assume an 'expected' (unfished) population size distribution that includes more larger fish than are recorded in the observed length data (Hordyk *et al*., 2015a; Fitzgerald *et al*., 2023). Input estimates of M/k also inform the expected size distribution, and hence, can bias outputs. The ideal would be to obtain stock-specific estimates of L_∞ and M/k, which would propagate into more accurate estimates of F/M and SPR. Characterizing growth patterns using length data requires a year of monthly sampling for tropical systems when lack of clear annual growth increments complicates aging from scales or otoliths.

As the NRDDB monitoring programme develops, it could also be important to extend the LBM assessments to multiyear tools. Data could also be pooled across survey periods (once the survey is fully standardized) to increase the number of individuals, and support LB-SPR assessment of important but less abundant species. The advantages of increasingly complex assessment models must obviously be offset against local technical capacity and resources, and the potential for tracking fishery state using empirical and semi-quantitative LEK indicators. Limited resources are likely to mean that fish monitoring surveys only occur periodically, and so survey-based indicators, such as catch per unit effort (CPUE) and length-distributions, will only be available at this intermittent temporal resolution. A parallel surveillance series may come from reporting of commercial catch under the new North Rupununi management plan. These quantitative data could complement annual LEK surveys of fishery and broader ecological state, with potential for an ecosystem-based framework in which management responds to a range of information from both scientific- and community-based ways of knowing.

Despite the above-mentioned limitations, our study contributes to filling a knowledge gap about exploited fish stocks in the Guiana Shield (Shephard *et al*., 2023). There are relatively few formal state assessments for fish stocks in the region, with more knowledge for the bordering Amazon system (Petrere *et al*., 2004; Castello *et al.,* 2011; Shephard *et al*., 2021a). In Guyana, the previous focus has been on *Arapaima gigas* (Castello, 2001; Watson *et al*., 2021) and to our knowledge, there is no published assessment for the broader fish community. Our results suggest that stocks in the North Rupununi are not yet strongly overfished, although there is evidence of loss of larger individuals consistent with

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Makushi fisher hunting with a bow and arrow

size-selective exploitation. This conclusion matches reasonably well with local knowledge of the fishery. Fishers' LEK from the North Rupununi suggest that fish stocks around more remote communities are still relatively healthy, while those close to access roads have come under pressure. Larger and more desirable species, such as dawalu (*Ageneiosus inermis*) and red pacu (*Piaractus brachypomus*) in these vulnerable areas have been reported by Makushi community members to show reduction in mean size concordant with size-based assessment results (see Table 9; and Figure 11).

Moderate state for Rupununi fish stocks contrasts with the Amazon, where some stocks have been declining for decades (Bayley and Petrere, 1989; Petrere *et al*., 2004) and key species show clear signs of overexploitation (Castello *et al*., 2011; Shephard *et al*., 2021a). Our tentative conclusions about current stock status do not consider possible local depletions, e.g. close to fishing communities or regions with intense mining or logging. Future efforts to track state in specific locations could be supported by identifying indicator species. This group could include important commercial fishes as well as species with vulnerable life history or other biodiversity interest, e.g. high trophic level and larger fishes, including arawana (*Osteoglossum bicirrhosum*) and peacock bass. It would also be useful to consider a broader ecosystem approach and to include empirical fish community indicators. The current $L_{max5\%}$ indicator refers to individual species, but there is scope to evaluate change at assemblage scale, e.g. shifts in size distribution or maturation schedule that often follow size-selective fishing pressure.

A significant issue that is not explicitly addressed in the current analysis is local understanding of fishery state, and how this is perceived to have changed in recent decades. It could be very productive to consider the current scientific assessments more explicitly in the context of LEK, especially from Indigenous experts. There are numerous examples of how this could be done, but there are advantages in reproducible methods for expressing LEK as semi-quantitative state indicators (Shephard *et al*., 2021b) that can be interwoven

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A selection of fish caught in the North Rupununi

with numeric metrics, e.g. LBIs, to produce more holistic impressions of fishery state. Such a multistranded exercise could include evaluation of how fishing overlaps with terrestrial hunting, and whether changes in bushmeat hunting or burns adjacent to wetlands are likely to change pressure on fish populations. Important patterns could also be elicited regarding social economic changes in fishing communities.

Progress has been made on establishing a community-based monitoring and assessment programme for North Rupununi fisheries. The fish data collected so far were found to support length-based assessments of state for the more abundant species in the catch, and indicated provisionally that these stocks are probably not yet strongly overexploited. Lack of local assessments means that possible overfishing at community scales is not evaluated. The quality of these assessments will improve with additional survey years and more specific estimates of population life history parameters. Simple empirical and LEK indicators can also be used to track population and community state, to reveal important ecological change and to trigger candidate management action.

References

Bayley, P.B. & Petrere Jr, M. 1989. Amazon fisheries: assessment methods, current status and management options. *Canadian special publication of fisheries and aquatic sciences*, 106: 385–398.

Camargo, M., Giarrizzo, T. & Isaac, V.J. 2015. Population and biological parameters of selected fish species from the middle Xingu River, Amazon Basin. *Brazilian Journal of Biology*, 75: 112–124.

Castello, L. 2001. *Stock assessment and management of the Arapaima in the North Rupununi, Guyana*. Instituto de Desenvolvimento Sustentável Mamiraua. Amazonas, Brazil.

Castello, L., McGrath, D.G. & Beck, P.S. 2011. Resource sustainability in small-scale fisheries in the Lower Amazon floodplains. *Fisheries Research*, 110(2): 356–364.

Conservation International. 2002. The Kanuku Mountains Protected Area process: The community resource evaluations. Georgetown, Guyana.

Conservation International Guyana & IDB. 2015. The State of Food and Agriculture in the Rupununi, Guyana. Georgetown, Guyana. 93 pp.

Cope, J.M. & Hamel, O.S. 2022. Upgrading from M version 0.2: An application-based method for practical estimation, evaluation and uncertainty characterization of natural mortality. *Fisheries Research*, 256: 106493.

de Souza, L.S., Armbruster, J.W. & Werneke, D.C. 2012. The influence of the Rupununi portal on distribution of freshwater fish in the Rupununi district, Guyana. *Cybium: International Journal of Ichthyology,* 36(1): 31–43.

Duponchelle, F., Lino, F., Hubert, N., Panfili, J., Renno, J.F., Baras, E., Torrico, J.P., Dugué, R. & Nunez, J. 2007. Environment-related life-history trait variations of the red-bellied piranha *Pygocentrus nattereri* in two river basins of the Bolivian Amazon. *Journal of Fish Biology*, 71(4): 1113–1134.

Fitzgerald, C.J., Delanty, K. & Shephard, S. 2018. Inland fish stock assessment: Applying data-poor methods from marine systems. *Fisheries Management and Ecology*, 25(4): 240–252.

Fitzgerald, C.J., Droll, J., Shephard, S., Monk, C., Rittweg, T., Arlinghaus, R. 2023. Length-based assessment of an exploited coastal pike (*Esox lucius*) stock (Rügen, southern Baltic Sea) underscores the crucial relevance of growth and natural mortality for assessment outcomes. *Fisheries Research*.

Fonseca, A. da S. 2021. A dinâmica reprodutiva da bicuda *Boulengerella cuvieri* (SPIX e AGASSIZ, 1829) capturada no lago da hidrelétrica de Tucuruí, Pará. Universidade Federal Rural da Amazônia, Campus Belém.

Guerreiro, A., Amadio, S., Fabre, N. & Batista, V. 2018. Estimation of growth parameters of five fish species (Actinopterygii) caught in the central Amazon. *Acta Ichthyologica et Piscatoria,* 48(3): 303–313.

Henfrey, T.B. 2002. *Ethnoecology, resource use, conservation and development in a Wapishana community in the South Rupununi, Guyana*. University of Kent at Canterbury. UK.

Holley, M.H., Maceina, M.J., Thomé-Souza, M. & Forsberg, B.R. 2008. Analysis of the trophy sport fishery for the speckled peacock bass in the Rio Negro River, Brazil. *Fisheries Management and Ecology*, 15(2): 93–98.

Hommik, K., Fitzgerald, C.J., Kelly, F. & Shephard, S. 2020. Dome-shaped selectivity in LB-SPR: length-based assessment of data-limited inland fish stocks sampled with gillnets. *Fisheries Research*, 229: 105574.

Hordyk, A., Ono, K., Valencia, S., Loneragan, N. & Prince, J. 2015a. A novel length-based empirical estimation method of spawning potential ratio (SPR), and tests of its performance, for small-scale, data-poor fisheries. *ICES Journal of Marine Science*, 72(1): 217–231.

Hordyk, A., Ono, K., Sainsbury, K., Loneragan, N. & Prince, J. 2015b. Some explorations of the life history ratios to describe length composition, spawning-per-recruit, and the spawning potential ratio. *ICES Journal of Marine Science*, 72(1): 204–216.

Hordyk, A. 2019. LBSPR: Length-Based Spawning Potential Ratio. R package version 0.1.5. https://CRAN.R-project.org/package=LBSPR

ICES. 2015. *Report of the Workshop on the development of quantitative assessment methodologies based on LIFE-history traits, exploitation characteristics and other relevant parameters for data-limited stocks (WKLIFE V)*. 5–9 October 2015 Lisbon, Portugal. ICES CM: 1–157.

Ingwall-King, L. 2013. *The implications of spatial and temporal scale on the supply, distribution and value of ecosystem services in Guyana.* Royal Holloway University of London.

Lopes, P.F., Hallwass, G., Begossi, A., Isaac, V.J., Almeida, M. & Silvano, R.A. 2019. The challenge of managing Amazonian small-scale fisheries in Brazil. In: Salas, S., Barragán-Paladines, M. & Chuenpagdee, R. eds. *Viability and sustainability of small-scale fisheries in Latin America and the Caribbean*. MARE Publication Series (10): 219–241. Springer, Cham.

Loubens, G. & Panfili, J. 2001. Biologie de *Piaractus brachypomus* (Teleostei: Serrasalmidae) dans le bassin du Mamoré (Amazonie bolivienne). *Ichthyological Exploration of Freshwaters,* 12(1): 51–64.

Luzar, J.B., Silvius, K.M. & Fragoso, J. 2012. Church affiliation and meat taboos in Indigenous communities of Guyanese Amazonia. *Human Ecology*, 40(6): 833–845.

Mendes, Y.A., Ferreira, M.A.P., Lobato, C.M.C., Silva, G.M.F., Montag, L.F.A. & Rocha, R.M. 2017. Reproductive characteristics of pike-characids *Boulengerella cuvieri* (Ctenoluciidae) in the middle Xingu River, Eastern Amazon. *Journal of Fish Biology*, 91(1): 346–353.

Mistry, J., Simpson, M., Berardi, A. & Sandy, Y. 2004. Exploring the links between natural resource use and biophysical status in the waterways of the North Rupununi, Guyana. *Journal of Environmental Management,* 72(3): 117–131. https://doi.org/10.1016/j.jenvman.2004.03.010

Mistry, J., Berardi, A. & Simpson, M. 2008. Birds as indicators of wetland status and change in the North Rupununi, Guyana. *Biodiversity and Conservation*, 17(10): 2383–2409.

Mistry, J., Berardi, A., Haynes, L., Davis, D., Xavier, R. & Andries, J. 2014. The role of social memory in natural resource management: insights from participatory video. *Transactions of the Institute of British Geographers*, 39(1): 115–127.

Musinguzi, L., Bassa, S., Natugonza, V., van Steenberge, M., Okello, W., Snoeks, J. & Froese, R. 2021. Assessment of exploited fish species in the Lake Edward System, East Africa. *Journal of Applied Ichthyology*, 37(2): 216–226.

Oliveira, A.C.B., Soares, M.G.M., Martinelli, L.A. & Moreira, M.Z. 2006. Carbon sources of fish in an Amazonian floodplain lake. *Aquatic Sciences,* 68(2): 229–238.

Panthera Guyana. 2015. Workshop Report: Hunting sustainability and hunter awareness as a foundation for managing wildlife harvest in South Guyana and Roraima (USFWS). Manari, Lethem, Guyana.

Petrere, M., Barthem, R.B., Córdoba, E.A. & Gómez, B.C. 2004. Review of the large catfish fisheries in the upper Amazon and the stock depletion of piraíba (*Brachyplatystoma filamentosum* Lichtenstein). *Reviews in Fish Biology and Fisheries*, 14(4): 403–414.

Pons, M., Cope, J.M. & Kell, L.T. 2020. Comparing performance of catch-based and length-based stock assessment methods in data-limited fisheries. *Canadian Journal of Fisheries and Aquatic Sciences*, 77(6): 1026–1037.

Sá-Oliveira, J.C., Hawes, J.E., Isaac-Nahum, V.J. & Peres, C.A. 2015. Upstream and downstream responses of fish assemblages to an eastern Amazonian hydroelectric dam. *Freshwater Biology*, 60(10): 037–2050.

Shephard, S., Valbo-Jorgensen, J., Abadía, J., Baigún, C., Doria, C.R., Fabré, N.N., Isaac, V.J., Bun Ngor, P., Ruffino, M.L. & Funge-Smith, S. 2021a. From Amazon Catfish to Mekong Money Fish: Size-based Assessment of Data-Limited Commercial Inland Fisheries. *Fisheries*, 46(4): 170–187.

Shephard, S., Ryan, D., O'Reilly, P. & Roche, W. 2021b. Using local ecological knowledge to inform semi-quantitative fishery surveillance indicators: an example in marine recreational angling. *ICES Journal of Marine Science*, 78(10): 3805–3816.

Shephard, S., Edwards, K., George, S., Joseph, E., James, S., David, O., Persaud, A., Watson, L.C. & van Vliet, N. 2023. Community-based monitoring, assessment and management of data-limited inland fish stocks in North Rupununi, Guyana. *Fisheries Management and Ecology,* 30(2): 121–133.

Valbo-Jørgensen, J. & Poulsen, A.F. 2000. Using local knowledge as a research tool in the study of river fish biology: experiences from the Mekong. *Environment, Development and Sustainability*, 2(3): 253–376.

Watson, L.C., Stewart, D.J., Clifford, K., Castello, L., Jafferally, D., James, S., Norman, Z. & Watkins, G.G. 2021. Recovery, conservation status, and environmental effects on arapaima populations in Guyana. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 31(9): 2533–2546.

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A successful catch of Lukunani

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A fisher carefully removes a red piranha from his seine

2. Local uses of wildlife in the Rupununi

2.1. Institutions and normative framework regulating the use of wildlife

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Highlights

- The Guyana Wildlife Conservation and Management Commission (GWCMC) oversees the management of wildlife resources. At the local level, Amerindian village councils manage titled village lands and the resources thereof and make rules governing fishing and hunting.
- The institutions managing wildlife and fisheries resources allocate tenure rights through hunting and fishing permits and licences.
- The Fisheries Act and subsequent regulations have been designed for marine fisheries only, and currently there are no regulations in Guyana for inland fisheries.
- Though the Amerindian Act recognizes Amerindian subsistence rights, there are no provisions for sector regulations to define subsistence hunting and fishing.
- The definitions of hunting licences provided in the Wildlife Regulations are not entirely clear on the activities that can be conducted with each type of licence. The GWCMC published a guidance document to provide greater clarity on this subject; however, this is primarily educational material that should be supplemented by information with a more solid legal basis.
- The two main gaps in the current legal framework, with regard to sustainable wildlife management by communities, are the issues with the titling process of Amerindian's lands, and the lack of recognition of customary rights by sectoral law and regulations. Rights to use and manage wildlife are recognized, but only for titled lands, undermining the rights of Amerindians who do not benefit from a formal recognition of their customary lands.

Introduction

In this chapter, we describe the institutional arrangements and the normative framework regulating the use and management of wildlife in Guyana. We analyse sectoral regulations and identify main challenges and opportunities to ensure sustainable use of wildlife resources by local communities and Indigenous Peoples.

Guyana's Constitution, adopted in 1980, is the supreme law of the country. It provides for sustainable development and use of natural resources as a duty of the state to ensure citizens' rights to a healthy environment. The diversity of plants, animals and ecosystems is recognized as a necessary element for the

well-being of the nation. The Guyana Wildlife Conservation and Management Commission (GWCMC) oversees, at the national level, the management of wildlife resources to ensure their conservation and sustainable use. The GWCMC was established in 2017 by the Guyana Wildlife Conservation and Management Act of 2016.

Meanwhile, the Amerindian Act of 2006 defines an Amerindian as any citizen who belongs to, or is a descendant from, any of the native or aboriginal peoples of Guyana (Akawaio, Arekuna, Patamona, Waiwai, Makushi and Wapishana). The national Constitution provides special rights and agencies for the representation of Amerindians. The Amerindian Act distinguishes between Amerindian villages and Amerindian communities on the basis of the formal land rights they hold. Whereas Amerindian villages have formal titles over village lands, Amerindian communities do not have formal titles over their customary lands' and therefore, are deemed to occupy state lands. At the local level, village councils oversee wildlife resource management.

Institutional frameworks and normative systems governing sustainable wildlife management

The Wildlife Act provides "for the protection, conservation, management, sustainable use, internal and external trade of Guyana's wildlife". It has a strong focus on external trade as it implements the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The Wildlife Act also establishes the functions of the GWCMC as the national institution overseeing wildlife management. Among its functions, it is in charge of granting, amending and cancelling licences, permits and certificates with respect to the use of wildlife. Subsidiary regulations have been issued under the Wildlife Act. These are the Wildlife Conservation, Management and Sustainable Use Regulations of 2019, Management and Sustainable Use Regulations, hereinafter referred to as the "Wildlife Regulations". These provide rules for the domestic use and trade of wildlife resources, including hunting, transport and sales licences and permits. The Wildlife Holding Premises Regulations and the Wildlife Zoo Regulations were also issued in 2018 under the Wildlife Act to provide rules for wild animals in captivity.

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Yupukari village seen from above

The Fisheries Act of 2002 "provides for the promotion, management and development of fisheries". It establishes responsibilities and powers of the Ministry of Health and the Chief Fisheries Officer (within the Ministry of Agriculture) with respect to fisheries. Fisheries officers may be appointed as necessary to give effect to the Act. The minister may also appoint a fisheries advisory committee to advise on the management and development of fisheries. Further regulations have been issued under the Fisheries Act, such as the Fishery Products Regulations of 2003, the Fisheries Regulations of 2018 and the Fisheries (Exemption from Registration and Licensing) Order of 2018. Although the Fisheries Act and subsequent regulations are silent on their applicability to inland fisheries, analysis of the discussions that led to their adoption shows that these texts were designed to be applied only to marine fisheries. In this sense, there are no current regulations in Guyana for inland fishing.

Legal instruments from other sectors regulate matters related to wildlife, such as the Forests Act of 2009 and Protected Areas Act of 2011. The Guyana Forestry Commission is the management authority of all state forest lands, while the Protected Areas Commission establishes and manages the national protected areas system. The Amerindian Act establishes the functions of village councils at the level of Amerindian villages. Among their functions, village councils manage the sustainable use of village lands and their resources, and make rules governing related aspects, including hunting and fishing. Village councils also manage and regulate the occupation of village lands. The powers provided by the Amerindian Act in relation to land management are exclusive to village councils within their village lands (titled lands). In this sense, the mentioned functions leave aside customary and non-titled lands, and therefore, Amerindian communities that do not benefit from land titles. Indeed, the powers and functions of community councils, which are the representative bodies of Amerindian communities, are very limited in comparison to those of village councils.

Village councils and community councils are chaired by Toshaos (elected village leaders), who can represent the interests of the village or the community at the national level in the National Toshaos Council established under the Amerindian Act of 2006.

Although ecotourism is not specifically regulated, it is mentioned in the Forests Act and the Protected Areas Act. The Guyana Tourism Authority is in charge of developing the tourism industry in the country. The Guyana Tourism Authority Act of 2002 establishes the functions of such an organization in relation to tourism, but no specific functions in relation to ecotourism are provided.

Wildlife status/tenure and the real rights pertaining to wildlife

Wildlife is given an independent legal status under the Wildlife Act, and is defined as "any non-domestic organism in the kingdoms of animals, plants, chromista, protista, prokaryota and fungi". The definition of fish under the Fisheries Act falls under that concept of wildlife. This might create an overlap between the regulations governing wildlife and those governing fisheries, and a conflict of competences between the different management institutions.

There are no explicit provisions stating that wildlife is state property; however, this can be inferred as the statutory management institutions from both the fisheries and wildlife sectors can allocate tenure rights through hunting and fishing permits and licences. Regulations do not establish explicitly whether wildlife and fish legally extracted from their natural environment under a licence or a permit become private property.

Status of hunters/fishers (subsistence, commercial, sport)

The Amerindian Act recognizes Amerindian traditional rights as defined as:

Any subsistence right and privilege in existence at the date of the commencement of this Act, which is owned legally or by custom by an Amerindian village or Amerindian community and which is exercised sustainably in accordance with the spiritual relationship which the Amerindian village or Amerindian community has with the land.

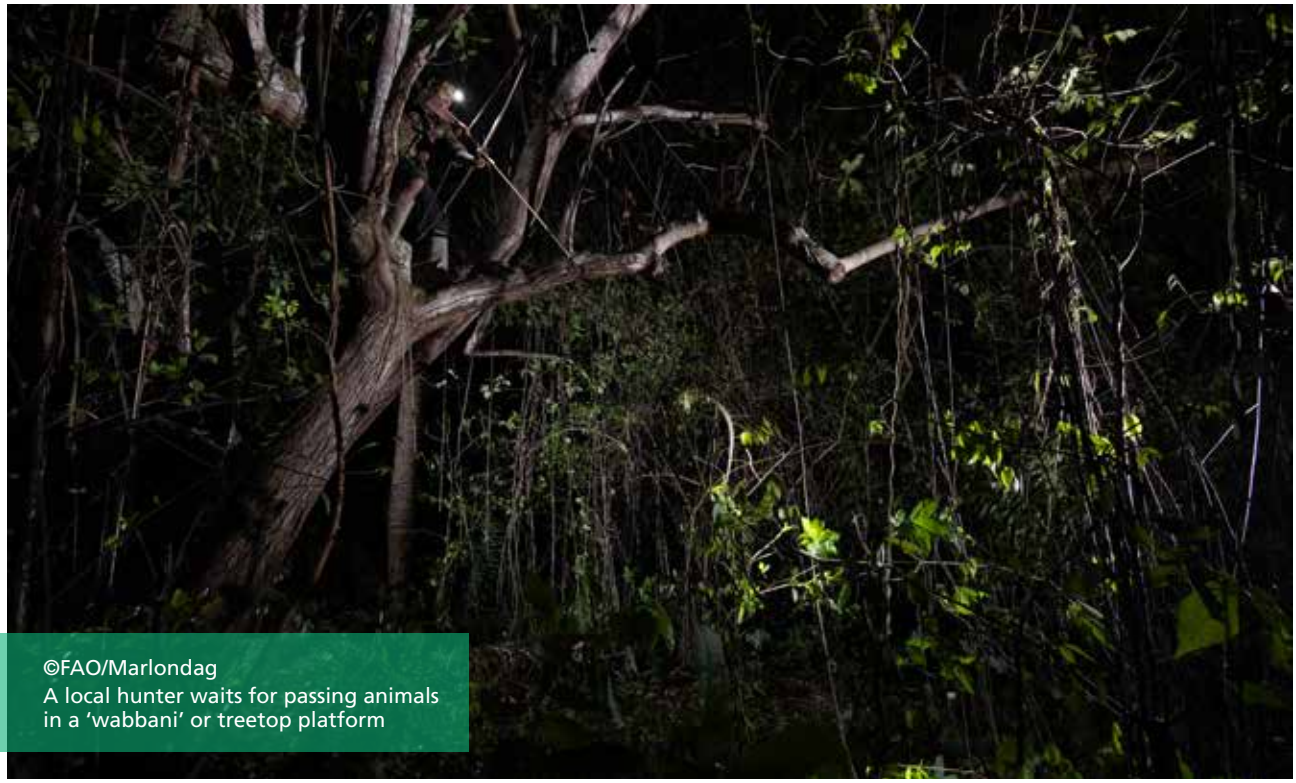
It can be inferred that traditional rights include hunting and fishing for subsistence, but this is not clearly stated. There are no similar provisions allowing subsistence use for people who do not belong to Amerindian villages or communities.

Even though the Amerindian Act recognizes traditional rights, the wildlife and fisheries regulations do not explicitly establish such rights in relation to wildlife and fisheries resources. However, as mentioned before, the applicability of the fisheries regulations is limited to marine fisheries, so there is nothing in the legal framework preventing subsistence fishing rights for Amerindians over inland waters. The Wildlife Regulations do not explicitly exclude subsistence activities linked to traditional rights from licensing requirements. They only provide for some exemptions related to wildlife collecting and captive breeding that may be granted to Amerindian villages and communities by the minister (of the Presidency) for subsistence, medicinal or other purposes.

Licencing system for hunting/fishing (subsistence, commercial, sport) and ecotourism

The Wildlife Regulations establish the following licences for hunting activities: wildlife trapping licences, wildlife collecting licences, wildlife commercial licences, wildlife recreational licence s and, special wildlife licences. The descriptions of the licences provided in the Wildlife Regulations are not entirely clear on which activities are permitted under each type of licence. These gaps have been partially filled by a document circulated by the GWCMC indicating the types of licence required for each activity.

Trapping is defined under the regulations as "taking, capturing or killing or attempting to take, capture, kill wildlife by any means or contrivance". According to GWCMC documentation, trapping licences are for individuals who harvest wildlife for subsistence use or sale, as well as for legally recognized village councils that propose to trap wildlife for sale to licenced vendors and intermedi-



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A local hunter waits for passing animals in a 'wabbani' or treetop platform

aries. Village councils can obtain a collective wildlife trapping licence allowing a specific number of persons to trap for the benefit of the village with the approval of the village council. The regulations do not specify whether these collective licences cover only village lands, or whether they can also include customary hunting lands (e.g. state lands for which Amerindian villages have already filed extension claims under the Amerindian Act).

According to the GWCMC, a wildlife collecting licence is required to transport species for sale. Collecting is defined in the Wildlife Regulations as "gathering, harvesting, receiving, in whole or in part of any animal or plant and also includes every attempt to take such animal or plant and every act of assistance to any person to take such animal or plant or parts or derivatives thereof". It is not entirely clear whether this refers only to collecting animals from hunters/trappers, or whether it can also include the extraction of animals from their natural environment by any means.

The wildlife commercial licence is required to trade wildlife and wildlife products at a single place of business. Hunting for personal leisure (without commercial purposes) would require a wildlife recreational licence. The wildlife captive licence is required to keep in captivity more than eight specimens for leisure or for breeding and ranching purposes. Finally, the special wildlife licence is required to hold wildlife for scientific and/or collection purposes.

Both the Fisheries Act and the fisheries regulations establish different types of vessel licences related to fishing activities over marine waters. A foreign fishing vessel licence is provided for vessels from foreign nationalities. The local fishing vessel licence is established for vessels wholly owned by the State of Guyana and public corporations established by, or under, the law of Guyana, as well as those wholly owned by local fishing companies, associations and corporations or by natural persons who are citizens of Guyana. The commercial licence is required to engage in commercial fisheries activities. Research permits allow the holder to undertake fisheries-related research or survey operations. The Fisheries Act also establishes import

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Hydra, the first capybara at Wichabai Ranch's pilot farming project

and export licences. There is no specific licence or permit to carry out sports fishing activities. It might be inferred that local and/or foreign fishing vessels should apply for such a purpose depending on the nationality of the vessel; however, this is not clearly stated. Regarding fishing activities without a vessel, nothing in the legal framework is mentioned. However, as licences are attached to vessels, it might be inferred that no licence or permit is required in this case.

The Wildlife Regulations and the fisheries regulations provide conditions and requirements for licences and permit, and establish that those are not transferable. The Wildlife Regulations set conditions or elements that each type of licence includes: the licence shall determine the equipment to be used, the validity period, and other conditions set by the commission. The fisheries regulations establish application and licence forms for each type of licence (local, foreign, commercial, import and export) in their third schedule. Obligations to report are set for both fishing and wildlife licences. Except for the wildlife recreational and the special wildlife licences, which do not specify a validity period, all the other hunting and fishing licences are valid for one year and shall be renewed annually. Schedules in both wildlife and fisheries regulations provide the cost of obtaining a licence.

With respect to ecotourism, the legal framework provides a licensing system to operate a tourism business. However, there is no specific licensing system for an ecotourism specified business (ESB).

Determination of exploitable species for hunting/fishing (subsistence, commercial, sport) and ecotourism activities

The Wildlife Regulations establish a list of wildlife and fish classified in vulnerable, endangered and critically endangered species (first schedule), and provide for the inclusion, reclassification, and deletion of species from the list according to available scientific knowledge. It also allows institutions or individuals in possession of scientific, traditional and anecdotal knowledge to inform the GWCMC on changes of a species' status. The list shall be broadly disseminated through the Commission's website, a daily newspaper and any other manner that could bring attention of interested people. The regulations do not provide for the inclusion of names in Amerindian languages and pictures or drawings. They do not specifically provide either for awareness-raising activities to disseminate the list within communities.

Regulations on both wildlife and fisheries provide for the listing of hunting/fishing species in compliance with CITES and the International Union for Conservation of Nature (IUCN). The list mentioned above is consistent with the IUCN Red List, as all its species are classified within vulnerable, endangered, or critically endangered categories. The Wildlife Act also provides a list consistent with CITES appendices in relation to CITES permits for international trade.

It establishes first, second and third schedules in which CITES appendices I, II and II are contained, respectively. In addition, any amendment to the CITES appendices is considered an automatic amendment to the schedules.

The Wildlife Regulations establish as offences the collecting, holding in captivity, killing, or otherwise molesting classified wildlife. Sanctions for these offences are fines and imprisonment. The fisheries regulations establish that a licence may be suspended or revoked if any of the regulations in relation to protected turtle species and turtle excluder devices are breached.

Determination of hunting/fishing and ecotourism areas (spatial closure) and/or quotas for hunting/fishing (subsistence, commercial, sport)

The Wildlife Act provides for an annual export quota to be established by the GWCMC on the advice of the Wildlife Scientific Committee. Global quotas are not established for licences applicable to internal use and trade based on wildlife monitoring and scientific knowledge. However, the Wildlife Regulations establish that each type of hunting licence may specify the sizes, numbers and species of wildlife to be hunted, collected or

trapped. The specification of quantities in licences is not mandatory, as this is established as an aspect that licences "may" include. There are no criteria in the legal framework to determine when a licence shall include a specification on the number of species to be harvested.

The Fisheries Act establishes that the fisheries plan shall include licensing programmes to be followed by the fisheries, including limitations to be applied to local fishing operations and the amount of fishing, if any, to be allocated to foreign fishing vessels.

Geographic limitations may be specified in hunting licences. The Wildlife Regulations establish that the special wildlife licence shall be specific to a particular area. The other types of licence may specify the areas in which the activity is to take place. As in the case of quantities, the specification of areas is not mandatory either (except for the special wildlife licence), and no criteria is established to determine whether a licence shall specify or not the harvesting area.

The Wildlife Regulations provides for the GWCMC to enter into agreements with other government institutions (the Guyana Forestry Commission, the Guyana Lands and Surveys Commission and the Guyana Geology and Mines Commission) or with private landowners for the use of the land or area controlled by the institutions for the management, conservation and protection of wildlife. These agreements are accompanied by programmes for wildlife conservation areas that are subject to existing Amerindian rights under formal titles, concessions, permits and leases. In this sense, the programmes are not subject to the traditional rights recognized by the Amerindian Act, but only to the rights that are expressly granted by the government through licences, permits, concessions, leases and titles.

The Fisheries Act establishes that the minister may declare any areas of the fisheries' waters as marine reserve areas where fishing is not allowed unless specific permission is granted. These areas are only provided for marine zones and not for inland waters. The minister may also make regulations related to fishing closed areas and declare areas where fishing activities are prohibited.

Regarding ecotourism, the Forests Act and the Protected Areas Act include some provisions related to

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Local Makushi fisher checks his seine

geographic localization. According to the Forests Act, ecotourism is included as part of the elements of forest conservation operations. It is also mentioned as an activity for which a use permit may be granted over state forests. The Protected Areas Act establishes that a management plan may include provisions for ecologically sustainable tourism within protected areas or in partnership with local communities. Despite such provisions allowing ecotourism within state forests and protected areas, there is no limitation to only those specific areas.

Determination of operating seasons for hunting/fishing (subsistence, commercial, sport) and ecotourism activities

The Wildlife Act establishes, as a function of the GWCMC, publication of the annual closed season that must be based on consultation with stakeholders and based on scientific research. The closed season must be declared within 21 days of the commencement of each year, by notice in the official gazette, and its provisions may vary from time to time by a notice published in the official gazette. The Wildlife Regulations also establish that the Commission, in consultation with the Wildlife Scientific Committee – also established in the Act of 2016 to advise the GWCMC – and considering the traditional knowledge and hunting practices of Amerindians, may declare an additional closed season.

It is not clear whether closed seasons apply to subsistence hunting by Amerindians. Besides, there are no provisions stating to which lands (i.e. village lands, customary lands or any other lands) these rules apply. Although the Wildlife Conservation and Management Act provides for consultation with stakeholders to determine the relevant closed seasons, the regulations do not provide for a specific consultation process with Amerindian communities and villages. The Wildlife Act and the Wildlife Regulations do not establish general provisions applying to closed seasons, such as prohibitions of female catches during reproductive cycles.

Regarding fisheries, the Fisheries Act establishes that the minister may attach conditions to fishing licences or any category, related to open and closed seasons. The minister may also make regulations prescribing closed seasons. These regulations are very general and do not provide for how and when closed seasons must be set, updated, communicated, etc.

Determination of operating methods for hunting/fishing (subsistence, commercial, sport) and ecotourism activities

The Wildlife Regulations establish some provisions on methods attached to licences. The wildlife trapping licence specifies the equipment to be used, with consideration of humane trapping standards. The recreational licence also specifies the equipment to be used as well as the prohibited weapons, and includes a copy of a valid firearm licence (if a firearm is to be used). Section 24 of the Wildlife Regulations establishes as an offence the use of devices or methods specified in the fourth schedule. However, there is no fourth schedule contained in the regulations, so in this sense, the current regulations do not provide a list of prohibited methods and devices for wildlife hunting and trapping. Sizes of specimens may also be specified in hunting licences; however, that is not part of the mandatory elements.

In respect to fishing methods, the fisheries regulations establish that the Chief Fisheries Officer shall approve the fishing methods and materials to be used in fishing activities at the time of issuing the licence or permit. Additionally, fish pens or pin-seines, as well as fish aggregating devices, require a permit before installation. The fisheries regulations also establish that all trawler-type vessels rigged to fish in the fisheries waters shall be fitted with a bycatch reduction device which shall always be in use when fishing. The minister may also attach to fishery licences conditions on minimum sizes for species, and may issue regulations governing this aspect. Besides this general provision, the regulations on methods (e.g. minimum mesh sizes) also regulate minimum sizes for species.

The fisheries regulations and the Wildlife Regulations establish offences related to fishing and hunting methods. The fisheries regulations provide for

a fine as a sanction when there is a breach related to a trawl net without a turtle excluder device. The Wildlife Regulations establish a fine as a sanction for the use of devices or methods specified in the fourth schedule. However, as mentioned before, there is no fourth schedule.

Human–wildlife coexistence

According to the Wildlife Regulations, it is not unlawful for any person to kill or wound wild animals in self-defence or in defence of any other person when it is immediately and absolutely necessary. The regulations also establish some provisions related to the rights and obligations of private landowners concerning wildlife causing a nuisance over their lands. Private landowners or occupiers may kill animals causing or threatening to cause damage to livestock, crops, water installations or fences over the land. As an obligation, such killings should be reported as soon as possible to the nearest officer or police station. The GWCMC may relocate or authorize the relocation of wildlife causing a nuisance. There is no compensation system for damages caused by wildlife.

Conclusions and recommendations

Main gaps arising from the legal framework regarding sustainable wildlife management by communities have their roots in the land demarcation process of Amerindian lands and in the lack of recognition by sectoral law and regulations of customary rights enshrined in the Amerindian Act.

The land issues have direct incidence on sectoral law and regulations application. While some provisions from the Wildlife Act and the Wildlife Regulations grant rights to communities for the use and management of wildlife, they are limited to formal titled lands, such as the powers of village councils in respect to the management of village lands and their natural resources, or the possibility for village councils to apply for a collective licence to trap wildlife for sale. These limitations undermine the rights of Amerindian communities without formal land titles and the rights of Amerindian villages that have claimed extension as their land titles do not cover the total extent of the customary area.

Although the Amerindian Act recognizes Amerindian traditional rights understood as subsistence rights or privileges, there are no definitions on subsistence hunting and fishing in sectoral regulations. Clarification is needed on the scope of Amerindian subsistence rights to use wildlife, and over which areas such rights can be exercised (titled lands, state lands, customary lands). There is also a need to expressly state that subsistence hunting and fishing are excluded from licensing requirements. Currently, subsistence rights are only recognized for Amerindians; it is important to clarify if such rights can also be exercised by non-Indigenous people.

Current definitions on licences provided by the Wildlife Regulations are not entirely clear. The GWCMC issued a document providing guidance about the types of licences, since this is not reflected in the regulations. However, the document has no legal basis. The GWCMC could issue a soft law document, such as technical guidelines with clear definitions on the type of licence required for each activity (wildlife harvesting, trapping, transportation, holding in captivity, consumption, trade, etc.). To provide a legal basis to the document, it could undertake a formal issuing process, such as publication in the official gazette by the minister overseeing the GWCMC (Ministry of the Presidency). On the other hand, some elements are still missing to ensure the Wildlife Regulations can be fully applied: regulation 24 is inoperative at the moment as there is no schedule providing a list of prohibited methods related to collecting wildlife for hunters and trappers.

Although fisheries are regulated in different legal instruments, there is a lack of regulation in respect to inland fisheries and aquaculture. The Fisheries Act and its subsidiary regulations are applicable to marine fisheries,leaving inland fisheries unregulated.

Table 10. Hunting rights for Amerindians as defined in the legal framework of Guyana

Hunting rules are defined at the national level by the Amerindian Act of 2006 and the Wildlife Conservation, Management and Sustainable Use Regulations of 2019 ("the Wildlife Regulations") and at the local level by village council decisions. **The Amerindian Act of 2006 recognizes subsistence rights and privileges within customary lands, owned legally or by custom by Amerindian communities[a] and villages[b] (Amerindian Act, section 2). According to the licensing system issued by the GWCMC, Amerindian Villages (titled communities) can hunt non-protected species for subsistence over their titled lands without a licence. Amerindian communities (non-titled communities) will require a licence to hunt for subsistence purposes within non-titled lands; however, the licence is free of charge.*		
	Amerindian villages	**Amerindian communities**
What?	Amerindian villagers can hunt or trap any non-protected species for subsistence purposes. If hunting or trapping for purposes other than subsistence, Amerindian villagers can hunt or trap the species allowed by a licence issued by the GWCMC[c] according to the purpose: • A wildlife trapping licence is required to harvest and trap wildlife species for sale. A village council may apply and obtain a collective wildlife trapping licence indicating the number of people allowed to trap and sell wildlife. Any villager may obtain a permit from the village council to trap and sell wildlife under this licence. • A wildlife recreational licence is required to hunt for personal leisure. • A special wildlife licence is required to hunt wildlife for scientific and/or collection purposes. If an EPA research permit has been issued, then a no-objection letter would be required from the Commission instead of a special wildlife licence.	Amerindian community members can hunt or trap any non-protected species for subsistence purposes after applying for a licence (the fee for which would be waived if hunting for subsistence purposes). If hunting or trapping for purposes other than subsistence, Amerindian community members can hunt or trap the species allowed by a licence issued by the GWCMC[d] according to the purpose: • A wildlife trapping licence is required to harvest and trap wildlife species for sale. • A wildlife recreational licence is required to hunt for personal leisure. • A special wildlife licence is required to hunt wildlife for scientific and/or collection purposes.
How?	Amerindian villagers and Amerindian community members can hunt or trap with equipment that respects humane trapping standards when trapping for purposes other than subsistence. Amerindian villagers and Amerindian community members can hunt or trap with the equipment specified in the licence when hunting for purposes other than subsistence (a firearm licence is required for recreational hunting where a firearm is used).	
When?	Amerindian villagers and Amerindian community members can hunt or trap only during the open season for species under seasonal prohibitions[e], and all year round for other non-protected species.	
Where?	Amerindian villagers can hunt or trap within titled village lands. Amerindian villagers can hunt or trap within areas specified in the licence when hunting or trapping for purposes other than subsistence.	Amerindian community members can hunt or trap within areas specified in the licence.

[a] An Amerindian communities are defined by the Amerindian Act of 2006 as "*a group of Amerindians organized as a traditional community with a common culture and occupying or using the state lands which they have traditionally occupied or used*".

[b] Amerindian villagers are the Amerindians that are resident in an Amerindian village. A resident is defined as "an individual (a) who is an Amerindian who was born in, lives in or has his *principal residence within the village (...); or (b) who lives within the village and is recognized as a resident by the membership* rules of that village", (Amerindian Act, section 2). Village lands are those recognized by a formal land title.

[c] The licensing process is available on the GWCMC website: http://wildlife.gov.gy/licensing-procedure/

[d] The licensing process is available on the GWCMC website: http://wildlife.gov.gy/licensing-procedure/

[e] The closed period for each species is published annually by the Guyana Wildlife Conservation and Management Commission (GWCMCo) in its website at https://wildlife.gov.gy/closed-seasons/ (this link is only for 2023 seasons. There is a tab to access all closed seasons).

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Makushi hunter, Alan Mandook, eats with his family at their farm camp

2.2. Hunting in Wapichan Wiizi

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Highlights

- Hunting and wild meat play an important role in the livelihoods and culture of Wapichan communities.
- We conducted 309 hunter interviews in 12 villages in the Wapichan Wiizi to assess hunting practices.
- About 24 percent of households have an active hunter in the family. Eighteen percent of hunters report hunting more than once a week, while 46 percent hunt once or twice a month, and the rest only hunt occasionally.
- The main motivation for hunting is to provide food for the family (mentioned by 98 percent of the hunters). About 19 percent of the hunters also obtain cash from the local sale of wild meat within the village, but the percentage varies greatly among the villages.
- Village hunts, a traditional practice whereby collective hunting parties are organized and the meat is shared with all households, are still practised one to three times per year for special occasions.
- Nearly all hunters still use traditional bows and arrows, although 31 percent also use manufactured guns.
- Generally, hunters walk to hunting sites (81 percent), but bicycles, motorbikes

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A Wapichan hunter goes on a hunt with his trusty dog

or horses were also mentioned as main transportation means to hunting grounds, by 44 percent, 21 percent and 17 percent of the hunters, respectively.

- Among the hunters, 14 percent reported population declines in the last 15 years, mostly for four species: savannah deer, armadillo, labba and tortoise.
- While this study identifies similarities in hunting practices with previous research, it also highlights changes, notably due to increased technology use (guns and motorbikes) over the past 15 years. Involving hunters in monitoring could aid in managing vulnerable species.

Introduction

Hunting and fishing are an integral part of Indigenous livelihoods and culture in the South Rupununi – one of the least densely populated regions of the world (0.42 people per km^2) with large intact patches of savannah and forest, where Indigenous Wapichan communities have maintained traditional subsistence activities for millennia (Read *et al.*, 2010). However, rapid changes are happening in their territory, the Wapichan Wiizi. Due to increased accessibility, a growing human population, an ongoing shift from subsistence to a cash economy, and the pressure from environmental factors such as climate change (Conservation International, 2002; Conservation International Guyana, 2015), traditional practices are evolving, thus potentially affecting wildlife populations. Studies carried out in the early 2000s showed that hunting had caused a change in behaviour among ungulates, making it more difficult to detect them through live sightings at hunted sites (Fragoso *et al.*, 2016). More recently, a study looking at the impact of hunting on wildlife occupancy around the Kanuku Mountains Protected Area (Hallett *et al.*, 2019) identified a shift in activity pattern and distribution in most commonly hunted species, particularly labba, peccary and deer. However, no association between occupancy and hunting was found for the 17 terrestrial mammals analysed. Forest cover was found to be the strongest predictor of community occurrence, while proximity

©FAO/Luke McKenna
A successful afternoon for a Wapichan fisher.

to the villages had a negative impact on the occurrence of tapir (*Tapirus terrestris*) and both species of long-nosed armadillos (*Dasypus* spp.). In the Wai Wai territory, just south of Wapichan Wiizi, hunting was found to be currently sustainable, primarily due to the low human population density and use of bow and arrow (Shaffer *et al.*, 2017b, 2017a; Shaffer, Marawanaru and Yukuma, 2017). Overall, wildlife population assessments suggest that hunting is sustainable for the wildlife populations, even though species might have changed their behaviours in response to it (and possibly to other human pressures, such as roads or village expansion), which could explain the perceived declines.

In this study, we looked at hunting as part of the livelihoods and culture of the Wapichan people inhabiting the South Rupununi. In particular, we analysed the motivations for hunting, the destination of the meat, hunting practices and species hunted. Our findings contribute to the evaluation of guidelines set forth in the first Wapichan Wiizi Wildlife Management Plan (WWWMP) (Chapter 4.2), and inform ongoing efforts in landscape and biodiversity management in the territory.

Methods

Between December 2021 and April 2022, 309 surveys were conducted in 11 villages of the Rupununi: Aishalton, Awarewaunau, Karaudarnau, Katoonarib, Katur'ur, Maruranau, Potarinau, Sawariwau, Meriwau, Quiko, and Shulinab (see Table 11). The objective of the surveys was to understand hunting practices, meat use and species hunted. In each community, hunters were selected based on a snowball approach, starting with a known hunter. The interviewee was then asked to indicate another household where at least one hunter lived. The survey included general questions on the hunter; the type of hunts in which they participated (planned hunts for subsistence use, village hunts, commercial hunts, opportunistic hunting only); the frequency of hunting; the motivation for hunting; method(s) used; species hunted; and use of the game (household consumption, sharing with other households, selling within the village, selling in mining areas, selling in Lethem, selling to middlemen). The survey also addressed hunting traditions and whether they were being passed on to children. Finally, the hunters were asked about their perceptions regarding wildlife increases or decreases in their area. All interviews were conducted in the primary language of the interviewee (Wapichan, English or Portuguese) by trained residents of the village where the research was taking place.

Table 11. Overview of interviews conducted per village

Village	#People	#Households	#Hunters interviewed
Aishalton	1 265	256	13
Awarewaunau	721	130	71
Karaudarnau	1 038	200	71
Katoonarib	468	85	49
Katu'ur	139	21	3
Maruranau	836	225	35
Potarinau	613	120	18
Sawariwau	549	106	30
Shulinab	770	133	19
TOTAL	**6 399**	**1 276**	**309**

Source: Paemelaere et al. 2023. CIFOR-ICRAF.

Results

Hunting as part of livelihoods

On average, 24 percent of households surveyed have an active hunter in the family. Among the hunters, 18 percent reported hunting at least once a week, while 46 percent hunt once or twice a month. Frequency of hunting was highest in Sawariwau and Katoonarib, where 67 percent and 53 percent of hunters, respectively, reported hunting at least once a week. Hunting frequency was lowest in Awarewaunau, Maruranau and Potarinau, with 13 percent, 23 percent and 28 percent of hunters, respectively, hunting at least once a week.

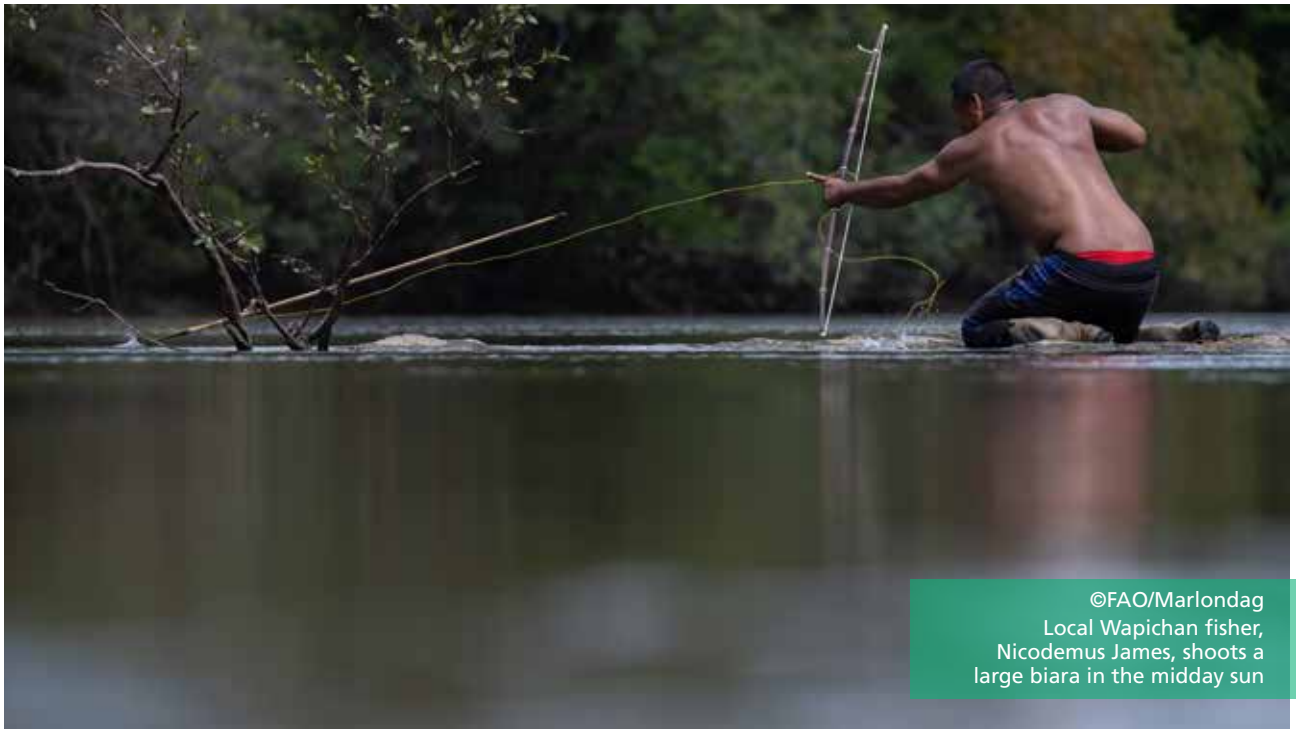
On average, 61 percent of the meat hunted was consumed by the hunter's own household. The rest was shared, bartered or sold. The main motivations for hunting were the 'provision of food for the family' (mentioned by 98 percent of hunters), followed by 'food for special occasions' (56

percent) such as birthdays and 'manoor' (a community gathering to work on a project, such as construction), and 'protection of the farm'. Hunting for cash income occurred among 19 percent of hunters, but varied greatly between villages. Wild meat trade was more common in Shulinab (78 percent of the hunters), Maruranau (63 percent) and Aishalton (62 percent). Hunting as a source of income was least reported in Sawariwau (7 percent) and Karaudarnau (1 percent). Other reasons for hunting included for ornamental purposes, for personal safety, to obtain skin, or for medicinal uses.

Hunting practices and traditions

Hunters differentiated "individual hunts", where individual hunters or small groups hunt for themselves, from "village hunts", where hunters hunt collectively for the community as a whole. Most individual hunts were planned. Unplanned hunts (e.g. hunting en route to the farm or to a fishing ground) were reported by only 16 percent of households, particularly in Maruranau (69 percent) and Aishalton (38 percent). Village hunts were only reported by Aishalton, Awarewaunau, Maruranau, Potarinau and Shulinab. Village hunts occurred one to three times per year for special occasions: Easter, Heritage Month (September), Christmas, or village meetings.

Generally, hunters walked to the hunting site (81 percent). Bicycles, motorbikes or horses were also mentioned as main transportation means to hunting grounds, by 44 percent, 21 percent and 17 percent of hunters respectively. Nearly all hunters used traditional methods (bows and arrows), although 31 percent combined them with non-traditional methods (manufactured guns). Nearly 50 percent of hunters taught their sons how to hunt with bows and arrows from a young age. Only 5 percent of hunters always used charms to go hunting, 85 percent stated they never used charms, while the rest used charms from time to time. Hunting lines (paths in the forest that belong to specific extended families) were still respected by 52 percent of interviewed hunters. Among those that hunted in lines belonging to other families, 80 percent would not ask for permission from the traditional owner.



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Local Wapichan fisher, Nicodemus James, shoots a large biara in the midday sun

Hunter perception of wildlife populations

Among the hunters, 14 percent reported population declines in the last 15 years (mostly in Katoonarib, Sawariwau and Maruranau) for four species: savannah deer, armadillo, labba and tortoise. Declines were mostly observed around the village and farming areas. An increase in a species population in the last 15 years was reported by 26 percent of hunters for agouti (27 percent).

Species hunted

On individual hunts, agouti (*Dasyprocta leporina*), armadillo (*Dasypus* spp. *Cabassous unicinctus*) and labba (*Cuniculus paca*) were most commonly hunted (see Figure 12). On the other hand, during village hunts, larger species such as white-lipped peccary (*Tayassu pecari*), bush deer (*Mazama americana*), tapir (*Tapirus terrestris*), savannah deer (*Odocoileus cariacou*), capybara (*Hydrochoerus hydrochaeris*), collared peccary (*Dicotyles tajacu*) and armadillos were most commonly hunted.

Conclusions and recommendations

In this study, we looked at the current role of hunting in the livelihoods and culture of Indigenous Peoples inhabiting villages in the Wapichan Wiizi. While only 24 percent of households had an active hunter in the family, non-hunting households benefited from wild meat through the common practice of sharing and bartering of meat, or when village hunts were organized. Overall, the main motivation for hunting was to provide a source of food for the family, or to share among families. Occasionally, some hunters would sell wild meat to obtain cash income or barter it with other goods. Wild meat still represents an important complement to the local diet of hunters and their families, with, on average, one-third of hunters consuming it more than once a week, and most others once or twice a month. Overall, agouti was the most commonly hunted species.

While we found many similarities in hunting practices to those reported in previous studies, there were also some indications of change in the hunting system (Conservation International,

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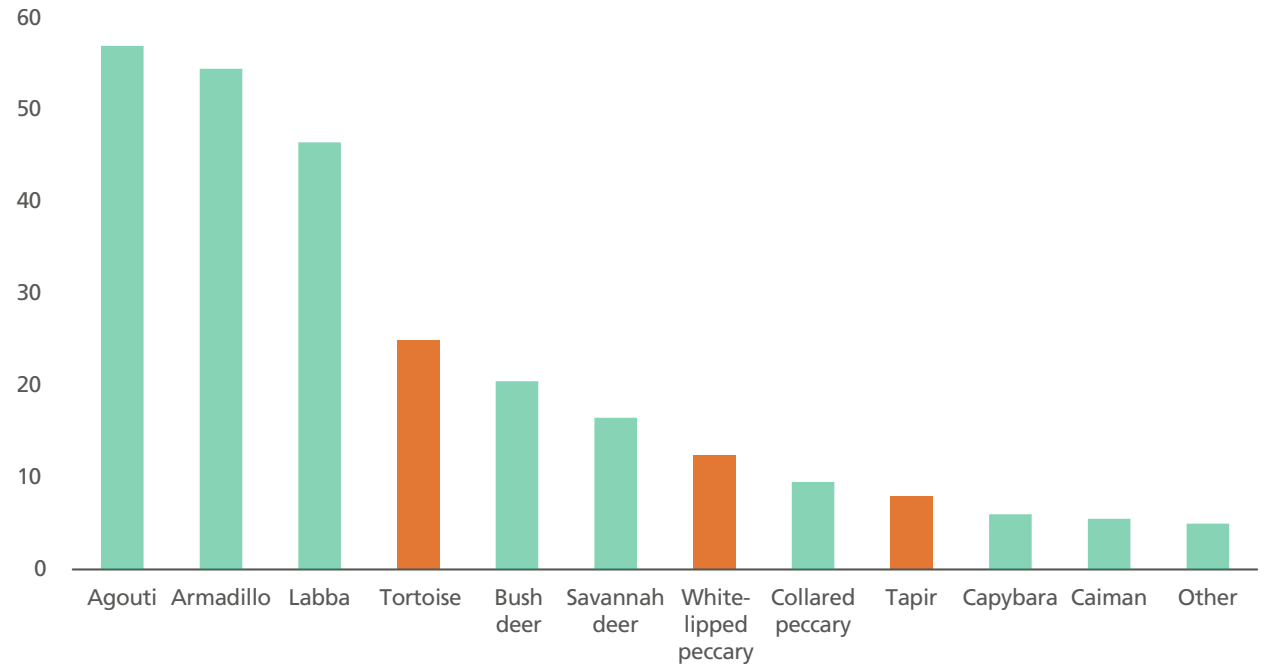
A hunter examines his catch: a black curassow

Figure 12. Species reported as most hunted in individual hunts; species (groups) in orange include threatened species



Source: Paemelaere et al. 2023. CIFOR-ICRAF.

2002; Read *et al.*, 2010). The percentage of hunting households found in this study is slightly lower than that found by Hallett *et al*. (2019) based on data collected in 2016. On the other hand, the percentage of hunters that use non-traditional hunting methods had increased from 24 percent in 2007–2009 (Read *et al*., 2010) to 31 percent in this study. While in 2007–2009, walking and bicycles were by far the most common forms of transport used to access hunting grounds (73 percent and 15 percent respectively) and motorbikes were absent, our study suggests that bicycles and motorbikes have become increasingly common, particularly in savannah villages (reported by 44 percent and 21 percent of hunters, respectively). The increased use of motorized means of transportation has also been highlighted among Xerente hunters in the Brazilian Cerrado, particularly motorcycles (De Paula *et al*., 2018). The use of such modern means of transportation allows hunting to be conducted in more suitable areas with higher concentrations of game species (Read *et al*., 2010).

The species caught in hunts also showed a slight, but potentially important shift. Two decades ago, Conservation International (2002) reported that large species such as deer, tapir, peccary and black currassow (*Crax elector*) were the most hunted species. In 2007–2009, (Read *et al.*, 2010) found labba to be the most commonly hunted species, closely followed by agouti and white-lipped peccary. In our study, the three most commonly hunted species were: agouti, labba and armadillo. Agouti is a disturbance-tolerant species. Seeing a high proportion of hunts with agouti as prey may suggest that hunting is happening in shifting cultivation mosaics, or that other preferred species are less easily encountered. It may also indicate changes in hunting skills or effort. Labba is perceived as having declined over the last 15 years, and this may explain why it is no longer the primary game. Three of the species that were perceived to have declined the most over the last 15 years were also among the ten most hunted species (savannah deer, armadillos and tortoise). These species are usually mostly

found in savannah areas where hunting pressure is higher as compared to the forest areas (Hallett *et al*., 2019). The sharp peak of white-lipped peccary hunts in 2007–2009, followed by a decline in our study, may be explained by the large-scale population disappearances and cycling typical of the white-lipped peccary, potentially due to density dependent over-compensation mechanisms (Fragoso *et al*., 2022).

Hunting is still an important part of the livelihoods and social constructions of Wapichan people. Our results indicate a need to support locally-based monitoring efforts for both hunting activities and wildlife populations. Monitoring data should be used to inform long-term wildlife management decisions.

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A traditional Wapichan dish known as damoorid: armadillo, cassareep, pepper and cassava bread

©FAO/Luke McKenna
Richard Peters searches for biara and tiger fish during this special season for shooting fish.

References

Conservation International. 2002. *The Kanuku Mountains Protected Area process: The community resource evaluations.* Georgetown, Guyana.

Conservation International Guyana. 2015. *The Rupununi economic and environmental Baseline Report.* Georgetown, Guyana 63 pp.

De Paula, M.J., Xerente, V. & Brito Pezzuti J.C. 2017. Hunting and Monitoring: Community-Based Research in Xerente Indigenous Land, Brazilian Cerrado. *Human Ecology Review,* 23(1): 23–43. https://doi.org/10.22459/HER.23.01.2017.02

Fragoso, J.M.V., Levi, T., Oliveira, L.F.B., Luzar, J.B., Overman, H., Read, J.M. & Silvius, K.M. 2016. Line transect surveys under-detect terrestrial mammals: Implications for the sustainability of subsistence hunting. *PLoS ONE*, 11(4): 1–18. https://doi.org/10.1371/journal.pone.0152659

Fragoso J.M.V., Antunes, A.P., Silvius, K.M., Constantino, P.A.L., Zapata-Ríos, G., Bizri, H.R.E. *et al.* 2022. Large-scale population disappearances and cycling in the white-lipped peccary, a tropical forest mammal. *PLoS ONE* 17(10): e0276297. https://doi.org/10.1371/journal.pone.0276297

Hallett, M.T., Kinahan, A.A., McGregor, R., Baggallay, T., Babb, T., Barnabus, H., Wilson, A., Li, F.M., Boone, W.W. & Bankovich, B.A. 2019. Impact of low-intensity hunting on game species in and around the Kanuku Mountains Protected Area, Guyana. *Frontiers in Ecology and Evolution*, 7 (November): 412. https://doi.org/10.3389/fevo.2019.00412

Read, J.M., Fragoso, J.M., Silvius, K.M., Luzar, J., Overman, H., Cummings, A., Giery, S.T. & de Oliveira, L.F. 2010. Space, place, and hunting patterns among Indigenous Peoples of the Guyanese Rupununi Region. *Journal of Latin American Geography*, 9(3): 213–243. https://doi.org/10.1353/lag.2010.0030

Shaffer, C.A., Marawanaru, E. & Yukuma, C. 2017. An Ethnoprimatological Approach to Assessing the Sustainability of Nonhuman Primate Subsistence Hunting of Indigenous Waiwai in the Konashen Community Owned Conservation Concession, Guyana. In: K.M. Dore, E.P. Riley & A. Fuentes, eds. *Ethnoprimatology: a practical guide to research at the human-nonhuman primate interface*, pp. 232–250. Cambridge, Cambridge University Press. (also available at http://ebooks.cambridge.org/ref/id/CBO9781316272466A107).

Shaffer, C.A., Milstein, M.S., Yukuma, C., Marawanaru, E. & Suse, P. 2017a. Sustainability and co-management of subsistence hunting in an indigenous reserve in Guyana. *Conservation Biology*, 31(5): 1119–1131. https://doi.org/10.1111/cobi.12891

Shaffer, C.A., Yukuma, C., Marawanaru, E. & Suse, P. 2017b. Assessing the sustainability of Waiwai subsistence hunting in Guyana by comparison of static indices and spatially explicit, biodemographic models. *Animal Conservation* (August): 148–158. https://doi.org/10.1111/acv.12366

2.3. Fishing for food security and local livelihoods in the North Rupununi

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Highlights

- Indigenous Peoples' food security in the North Rupununi relies heavily on fishing, and fish provide about 60 percent of their animal protein.
- Traditionally, fishing was a subsistence activity, but changes in the local economy and society (e.g. growing population, improvement of roads and transportation, shift towards a cash economy, and paucity of local job opportunities) have caused a surge in demand for local fish, leading to a concerning decline in fish populations, particularly large predatory species close to communities.
- Makushi households consumed about 3–5 lbs of fish per meal and approximately 86 percent of households consumed fish at least once per week between 2019–2020.
- Almost 98 percent of all interviewed households fished for personal consumption with over 30 percent selling and/or sharing a part of their catch.
- As revealed by a baseline assessment, continued monitoring of commercial fishing activities is crucial, especially for the species that are economically valuable to the Makushi communities, such as lukunani, arapaima, arowana, haimara, tiger fish/culit, lau lau, and other large catfish species.
- This chapter provides an overview of fishing practices in Makushi communities in the North Rupununi and highlights the critical role of fish in terms of food security and local economies.

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Kwatamang landing along the Rupununi River

Introduction

The North Rupununi region is an incredibly diverse ecosystem that covers approximately 1 146 000 ha of savannah and primary rainforest networked by large rivers, creeks, inlets, floodplain lakes and ponds. The largest river in Guyana, the Essequibo River, and its tributaries, the Rupununi and Rewa rivers, passes through the North Rupununi. The region experiences mean annual rainfall between 1 600 mm and 1 900 mm that peaks between the months of May and September (Mistry *et al*., 2008). During the main rainy season, much of the landscape floods when the rivers overflow their banks, spilling onto the forest floor and savannah creating vast tracts of wetlands and essential breeding grounds for the myriad species of fish and wildlife that inhabit the North Rupununi.

The North Rupununi region contains over 60 percent of fish species native to Guyana (de Souza et al., 2012; Taphorn *et al*., 2022). What makes this region a hotspot for biodiversity is its geology, which provides a direct connection to the Amazon River basin via the Takutu River in exceptionally wet years. The flood waters allow for the mixing of the Amazon and Essequibo river basins and their species, resulting in a remarkable diversity of habitats and wildlife, including endangered aquatic species such as the arapaima (*Arapaima* spp.), giant river turtle (*Podocnemis expansa*), black caiman (*Melanosuchus niger*) and giant otter (*Pteronura brasiliensis*).

The region is sparsely populated with approximately 8 000 residents of predominantly Makushi origin living in small rural communities (NRDDB census data, 2022). Fishing has always been a critical component of food security for Indigenous Peoples in the North Rupununi region, providing approximately 60 percent of animal protein in the diet of the Makushi (Mistry *et al.,* 2004, Luzar *et al*., 2012).

The Makushi are dependent on resources derived from the wetlands and rainforests, and maintain a close connection with their environment. The Makushi rely heavily on fishing, farming, hunting and gathering for their livelihoods, with community-based ecotourism presenting a small yet growing business opportunity. The Makushi are expert fishers and almost everyone in the communities, including children, engages in some type of fishing activity. Their extensive knowledge of fish and fish habitats allows them to skillfully catch fish throughout the year, with fishing activities reaching their peak at the beginning of the rainy season, when fishes migrate to the headwaters of rivers and creeks to spawn, and again when returning to the main river channels at the end of the wet season.

Fish also hold significant cultural and spiritual value for Indigenous Peoples in the North Rupununi region. Some stories and legends feature fish as important characters, such as the arapaima, which was regarded as the mother of all fishes. According to this legend, any harm that should befall arapaima will result in a cascading effect, causing all the other fishes in rivers, creeks and lakes to disappear. This belief dissuaded Indigenous Peoples from catching arapaima for centuries, until immigrant Amazonian fishers began harvesting the species in the 1970s (Watson *et al.,* 2022). There was limited harvesting of arapaima around the 1920s–1930s by a few balata harvesting companies to supplement their workers' meal kits.

Until the 2000s, fishing was done mostly for subsistence purposes. However, increased accessibility to the region, as well as growth in the local population, has led to an increase in the demand for local fish. The higher demand and the decline of many of the revenue-generating local sectors (i.e. harvesting of arapaima, giant otter, giant turtle and-black caiman, and cattle ranching) fueled uncontrolled levels of commercial fishing. This increased pressure on fish stocks with the introduction of non-traditional fishing methods, leading to noticeable declines in fish populations, particularly for large-bodied predatory fishes close to populated areas (Shephard *et al.,* 2022).

The goal of this chapter is to provide a brief description of the fishing practices among Makushi communities inhabiting the North Rupununi re-

gion and the importance of fish in terms of food security and local economies. We also present the results of a comprehensive assessment of the state of fisheries in the North Rupununi region for 2019–2020.

Fishing practices among the Makushi

For generations, the Makushi people have used a variety of fishing methods to catch a diverse range of fish species in the North Rupununi Wetlands. In addition to the traditional bows and arrows and spearfishing, the Makushi use fishing techniques that require traditional knowledge of both fishes and plants found in the region. There is a strong connection between the fishing techniques used by Makushi fishers and knowledge about fish behaviours, feeding and habitats.

During the dry season and when water levels are low in the main rivers, fishers dive below the surface of the water to catch certain species of catfish, such as amuris (*Platyoras* spp.), smoke hassa (*Hypostomus* spp.) and boots (*Trachycorystes* spp.) that shelter in holes within rocks or logs. These fishes are caught by hand. Spearfishing – using the point of an arrow – is another diving technique used by Makushi fishers.

Another traditional fishing method is the use of plant extracts containing poisonous chemical compounds that block the oxygen supply to fishes (e.g. van Andel, 2000). The two species of plants that the Makushi use are known locally as haiari (*Lonchocarpus densiflorus*) and kunami (*Clibadium asperum*). The practice of fish poisoning is perceived by Makushi fishers to be the most efficient and least time-consuming method (Jafferally, 2017). The poison of the haiari is released by smashing plant material, usually roots, against a hard surface found in the water (rocks or fallen logs) close to stagnant pools or sections of slow-flowing streams and rivers that have been temporarily dammed. Kunami plants, on the other hand, are prepared as balls by mixing their pounded leaves and fruits with freshly grated cassava or yam, which can be used fresh or fried. The pellets are tossed into fast-flowing water where they are eaten by fish. Temporarily deprived of oxygen, the fish floats to the surface and the fisher must dive and swim to

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Fisher, Leon Baird, uses a castnet to catch fish

catch the stunned prey before it recovers. The use of haiari occurs primarily when fishing is done by a large group of community members or the entire community, whereas the Kunami balls are used more for individual fishing endeavours (Jafferally, 2017).

Spotlight fishing is used primarily at night when a beam of light – usually from a flashlight – is projected along the edges of water bodies to locate fishes, which are then caught with the help of a cutlass. Another common traditional method is using a cadel (similar to a long line in marine fishing) where a series of hooks is tied to a mainline and dropped with floaters into the water body. Trawlling (dragging a baited fishing line behind a boat) is used to target large predatory fishes such as biara (*Hydrolycus* spp.), lukunani (*Cichla ocellaris*), black piranha (*Serrasalmus rhombeus*), swordfish (*Boulengerella cuvieri*) and pimelodid catfishes (often called 'skin fish'; *Pseudoplatystoma* spp., *Brachyplatystoma* spp., *Phractocephalus* sp.). Makushi people also weave fish traps from local palm or the bark of some tree species (kakaralli), which are used in combination with stop-offs made with logs, and set as barriers across creeks. These days, castnets, seines (gillnets are known locally as seines), and hook-and-line are commonly used. Castnets, in particular, are used for catching fish from drying out ponds/pools at the end of the rainy season. Seines are increasingly used for both subsistence and commercial purposes as they are more efficient than traditional methods. Fishing rods are common among visiting sport fishers, but rods made from slim, flexible yari-yari trees (*Chrysobalanaceae*) are often used by local fishers to catch small fishes.

Fishing activities typically decrease during the height of the rainy season, which occurs between April and August, when fishes disperse across the expansive flooded grasslands and forest floors to feed on the abundant food supply. This dispersion affects which species are caught. Conversely other hand, fishing increases at the beginning of the rainy season, when fishes move up - river and upstream to spawn, and again at the end of the rains, when water retreats and fish remain in drying pools. Fishing is done in rivers, creeks, oxbow lakes and ponds (seasonal), and often at night to avoid attracting piranha (since they can damage fishing lines), and to target large catfishes. Rivers are the preferred fishing location as they provide greater diversity and larger quantities of fish, followed by ponds and creeks. Historically, cultural beliefs restricted fishing in certain locations, mostly ponds, and for certain fish species such as arapaima, tiger fish/culit (*Pseudoplatystoma* spp.) and lau lau (*Brachyplatystoma* spp.). However, for the Makushi people, most of these 'cultural beliefs' are now disregarded, especially among younger community members.

Generally, subsistence fishing occurs in areas closest to homestead or farming sites. Nevertheless, fishing trips that last several days tend to occur in areas that are located at considerable distances from villages, and reaching these locations by paddling can take several hours and, at times, an entire day. Day-long or shorter fishing trips tend to occur closer to villages, but still at considerable distances from the main village sites. During subsistence fishing trips, families select preferred spots where they can target specific fish species, often lukunani, but also arowana (*Osteoglossum bicirrhosum*), haimara (*Hoplias aimara*) and tiger fish/culit, among others.

Species consumed

Of the 433 fish species that have been recorded in the Rupununi drainage (de Souza *et al.,* 2012), between 70 and 100 species (groups) are consumed by the Makushi people (Conservation International, 2002). Makushi people prefer to dine on lukunani and arowana, although the latter is no longer commonly caught. Haimara and yakutu (*Prochilodus rubrotaeniatus*) are also popular choices for consumption. Several fish species, such as pacu (*Myleus pacu*), cartabac (*Myloplus* spp., *Myleus* spp., *Pristobrycon* spp.), and dare (*Leporinus* spp.) are seasonal, in that they are caught at a higher rate during the rainy season when they move into flooded areas to feed on fallen fruits and seeds found beneath the forest canopy. The

top five fish species caught in the North Rupununi Wetlands are similar between the wet and dry seasons, except for huri (*Hoplias malabaricus*; most common in the dry season) and boot/imehri (*Trachycorystes* spp.; most common in the rainy season). In both seasons, biara provided the highest biomass. The species most commonly caught for sale locally are basha (*Plagioscion squamosissimus*), haimara, yakutu, tiger fish/culit (*Pseudoplatystoma fasciatum*), arapaima, biara, huri, lukunani and pacu (Conservation International, 2002).

Economic importance of the fishing sector

The Makushi people fish mostly for personal consumption and for sharing with friends and family. Nevertheless, region-wide surveys showed that fishing also contributes to incomes for 31.47 percent of households in the North Rupununi. The importance of fish as a source of protein increased in the early 1970s when livestock production started to decline due to a secessionist insurrection – the Rupununi uprising in 1969 – and an outbreak of foot-and-mouth disease (North Rupununi District Development Board and Iwokrama International Centre for Rain Forest Conservation and Development, 2011). Starting in the early 1990s, several factors slowly but steadily propelled the growth of the commercial fishery, including (i) a growing local population, particularly in Lethem; (ii) the improvement of roads between remote areas and markets, as well as greater access to motorized transportation; and (iii) the cultural shift towards a cash economy and the scarcity of job opportunities in the region.

Most of the fish destined for commercial purposes are sold through middle-persons to shops or restaurants and mostly in the population centres of Annai, Karasabai and Lethem. They, in turn, sell the fish to the end users/consumers. Some fish are also traded to the mining and logging camps located along the Essequibo River. Beyond the Rupununi, there is also a market for inland fishes on the coast, mainly in Georgetown. Demand from the coast is mostly driven by the Rupununian diaspora now living there. Outside Guyana, there is a growing but little-known market in Brazil, mainly in Normandy (11 772 people)[1] and in Boa Vista (436 591 people and larger than Guyana's capital city Georgetown)[2].

Fish also provide income through catch and release tourism, which is a relatively recent and expanding sector in the Rupununi. The most representative example of sport fishing success in the Rupununi is the community of Rewa, where "*catch and release for the endangered arapaima comes at a premium price and has successfully transformed a community of arapaima hunters into the guardians of their former prey*" (Paemelaere *et al.,* 2022). The Rewa Lodge offers sport fishing opportunities, and most tourists spend between USD 1 000 and USD 5 000 annually on recreational fishing, with some spending as much as USD 10 000 (personal communications). Most tourists are from the United States of America (USA) with a few from Europe and Japan. Additionally, there is a growing number of expatriate residents in Georgetown who work in the oil sector and are interested in sport fishing.

The state of fisheries in North Rupununi 2019–2020

Data collection

In 2019, with support from the Sustainable Wildlife Management (SWM) Programme, the North Rupununi District Development Board (NRDDB) piloted a comprehensive method to assess and monitor the fisheries sector in the North Rupununi. Data collection started in July 2019 and lasted until December 2020. In each of the 13 studied communities (Annai, Apoteri, Aranaputa, Crashwater, Fairview, Katoka, Kwaimatta, Kwatamang, Massara, Rewa, Surama, Yakarinta and Yupukari), two Community Resource Environment Workers (CREWS) were selected to carry out the interviews. Conducted at the household level, the semi-structured interviews included questions about general household characteristics, main sources of animal protein and fish consumption frequency, fishing practices, and

[1] https://cidades.ibge.gov.br/brasil/rr/normandia/panorama
[2] https://cidades.ibge.gov.br/brasil/rr/boa-vista/panorama.

the commercial use of locally caught fishes. A total of 787 households were interviewed and, in each household, we asked if there was a fisher in the house who was available to answer a specific interview on fishing. Questions included fishing practices, gear, fishing spots, most captured species, and use of catches. CREWS interviewed 78 fishers in total. In addition, a semi-structured interview was conducted with 67 different grocery stores within the studied communities to understand the importance of the local fish trade. This included questions on the most sold species, amounts sold per month, price, and buyers. Interviews were conducted using KoboToolBox, downloaded in tablets to ease data collection and processing.

Results

The Makushi rely heavily on local fish, and approximately 86 percent of households consume fish at least once a week.

Fishing frequency and use of catches differed between villages (see Table 12). On average, 58 percent of households engaged in fishing activities weekly (see Figure 13), and there was a high level (above 80 percent) of weekly fishing activities for the villages of Katoka, Massara and Rewa (see Table 12). In contrast, in Crashwater (87 percent) and Kwaimatta (69 percent), households preferred to go fishing daily. Some households fished monthly, primarily from the village of Surama (53 percent). When considering the quantity of fish consumed per meal per household, the most common amount was 3 to 5 pounds (lb) (see Table 12).

Fish that are caught are always consumed, with over 30 percent of households sharing and/or selling a portion of their catch (see Figure 14). Selling is an important activity for households in the villages of Yupukari (92 percent), Fairview (56 percent) and Kwaimatta (49 percent), while sharing appears to be important to the villagers of Apoteri (70 percent), Katoka (67 percent) and Yupukari (60 percent) (see Table 12).

River monitoring data was captured from a total of 134 boat owners or crew members. Most fishers were men (90 percent), but women were part of the crew for about 23 percent of the fishing trips. Women often participated in other fishing-related activities, such as fish preservation through smok-

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NRDDB team interviews a fisher along the river

ing or salting, which are the most common methods for preserving fish in the North Rupununi. Few fishers (11 percent) had access to ice boxes/coolers that could preserve the fish on ice. About 53 percent of the interviewees stated that fishing was the sole purpose of their trip, while about 47 percent indicated fishing was an activity that would be performed in addition to hunting, farming and collecting non-timber forest products (NTFPs). Dugout canoes (54 percent) were the main mode of riverine transportation, followed by aluminum (25 percent) and wooden (21 percent) boats, with only 29 percent of boats equipped with an outboard motor (2–40 hp).

The duration for the majority of fishing trips was one day (48 percent) with about 31 percent lasting one to three days, and even fewer lasting one week or longer (see Figure 16). Fishing gears included hooks and lines, bows and arrows, seines (gillnets), cadels and diving glasses and spears (see Figure 15). Only 56 percent of boats declared success at the end of fishing trips, with the majority of catches weighing around 22 to 44 lbs. Interestingly, 20 percent of boats that brought fish to the landing port indicated they had caught arapaima, with a total of 27 arapaima individuals recorded during the river monitoring survey.

Fishers also mentioned that they observed a decline in the availability of arowana, catfish, lukunaniand haimara. A total of 31 species were listed as targets for commercial fishing. The most commonly sought-after species for commercial purposes was lukunani, followed by pacu, haimara, tiger fish, biara and pakupa basha. Dawalu (*Ageneiosus inermis*), culit, amuri, cartabac and arowana were targeted by more than 10 percent of commercial fishers. The majority of grocery store owners interviewed listed lukunani as a favourite, followed by tiger fish and basha.

Finally, the data collected from interviews with grocery stores that operate in the North Rupununi indicated that fish is typically sold for GYD 400 per lb (USD 2). About 81 percent of the total number of local shops sold old fish products, with most selling between 55 and 110 lbs of fish per month. While fresh fish is the most commonly sold, frozen or salted fish were also available. Canned, smoked and roasted fish were available to a lesser extent, but were not products that originated in the North Rupununi. Purchasing fish for reselling was mostly opportunistic, with only one-fifth of stores having a regular supplier.

Conclusions and recommendations

This chapter provides a summary of the fisheries sector in North Rupununi with an updated status for 2019–2020. The information generated was used by the NRDDB to inform the Fisheries

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A fisher descales a Haimara

©FAO/Marlondag
Boiled fish being cooked at camp

Co-Management Plan for the North Rupununi Wetlands, which is presented in Chapter 4.1. The results from this assessment demonstrate that fishing continues to represent a key subsistence activity for Makushi communities, with approximately 98 percent of households fishing for personal consumption and about 86 percent consuming fish at least once per week.

Fishing also constitutes an important source of income, with the existence of an established intra-community market and growing demand from the coastal region of Guyana and nearby Brazil. While a variety of fishing methods are used, subsistence fishing is done with bows and arrows, and hooks and lines, while commercial fishing is most often practised using seines (gillnets) and castnets.

Perceptions of fishers indicate declining stocks of arowana, lukunani, haimara and some large catfishes, illustrating the need for continued monitoring of commercial fishing activities and the need to develop sustainable economic models for the fisheries sector. Open and closed seasons for small-scale, commercial and sport fishing activities are also needed, with accompanying national legislation to support local regulations. This is especially important, given increased access to the region and local population growth, which place heavy pressure on local fish stocks. The level of interest, knowledge and engagement, and existing management measures by communities bode well for strengthening co-management arrangements for inland fisheries resources in the North Rupununi Wetlands.

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A fisher 's hook and line caught lukunani

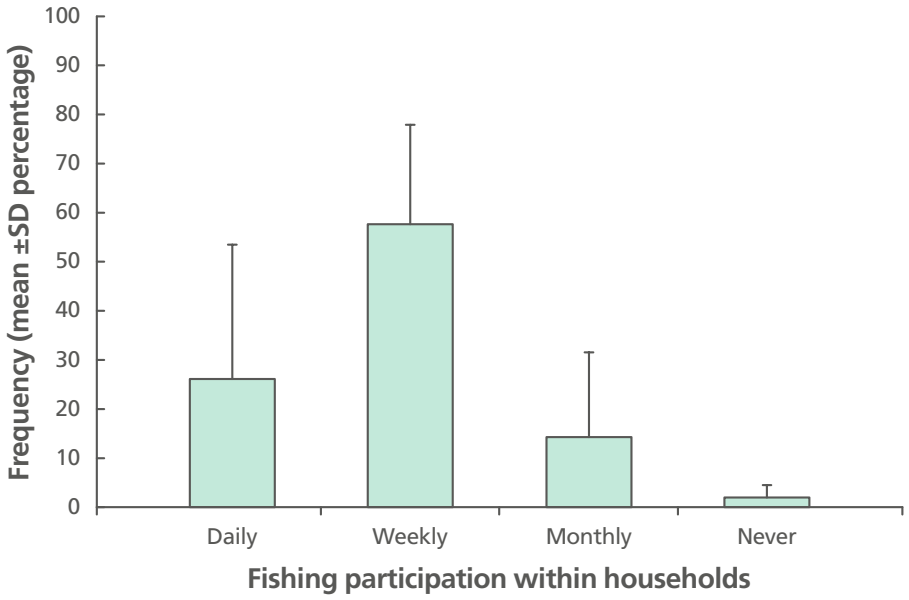
Table 12. Fishing activities and use of fish for the communities that participated in the 2019–2020 surveys

Communities	N	Catch own fish (%)	Frequency of fishing (%)				Fish consumed/ meal/household (interval mode; lbs)	Use of fish (%)			Data collection year
			Daily	Weekly	Monthly	Never		Consume	Sell	Share	
Annai	52	69	0	60	33	8	1–2	96	23	37	2020
Apoteri	83	100	27	69	2	2	4–5	100	19	70	2019–2020
Aranaputa	50	98	6	58	34	2	1–2	100	14	50	2020
Crashwater	46	98	**87**	13	0	0	3–4	85	7	13	2019–2020
Fairview	63	94	41	56	3	0	1–2	97	**56**	49	2019–2020
Katoka	84	96	1	**87**	10	2	3–5	100	39	67	2019–2020
Kwaimatta	61	95	**69**	30	2	0	3–5	98	**49**	10	2019–2020
Kwatamang	59	92	0	59	36	5	3–5	100	31	2	2019
Massara	41	98	7	**85**	7	0	3–5	100	41	46	2019
Rewa	146	98	16	**82**	3	0	3–5	97	1	18	2019–2020
Surama	43	93	2	44	**53**	0	3–5	98	16	21	2019
Yakarinta	34	85	35	56	3	6	3–5	100	21	9	2019
Yupukari	25	100	48	52	0	0	5–6	100	**92**	60	2020

Source: Hurtado-Gonzales, Jorge L. 2023. Canada.

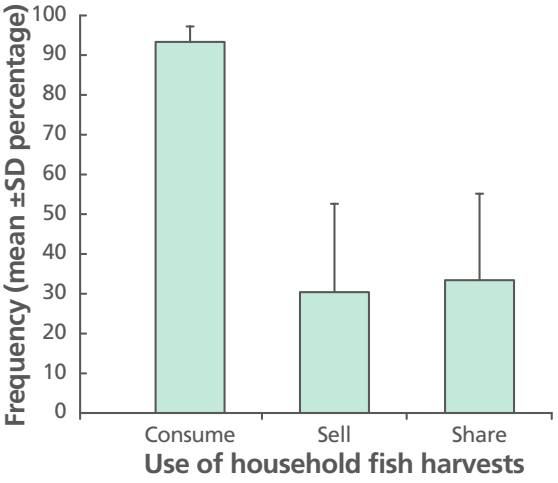
Note: N = the total number of households interviewed. The mode of fish consumed/meal/household represents the most common values of weight consumed indicated by households per meal

Figure 13. Mean ± standard deviation (SD) of the frequency of household fishing activities 2019–2020



Source: Hurtado-Gonzales 2023. Canada.

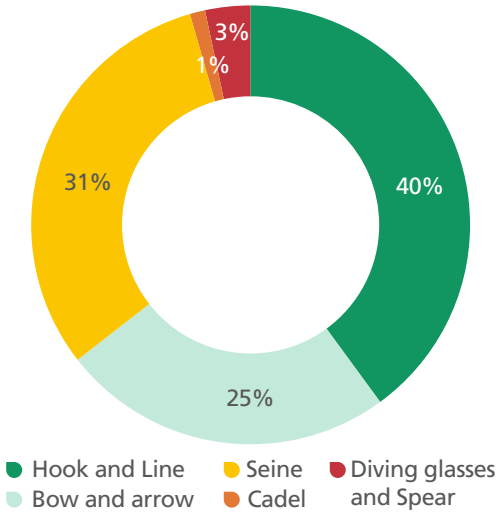
Figure 14. Mean ± standard deviation (SD) of the frequency of household use of fish harvests 2019–2020



Source: Hurtado-Gonzales. 2023. Canada.

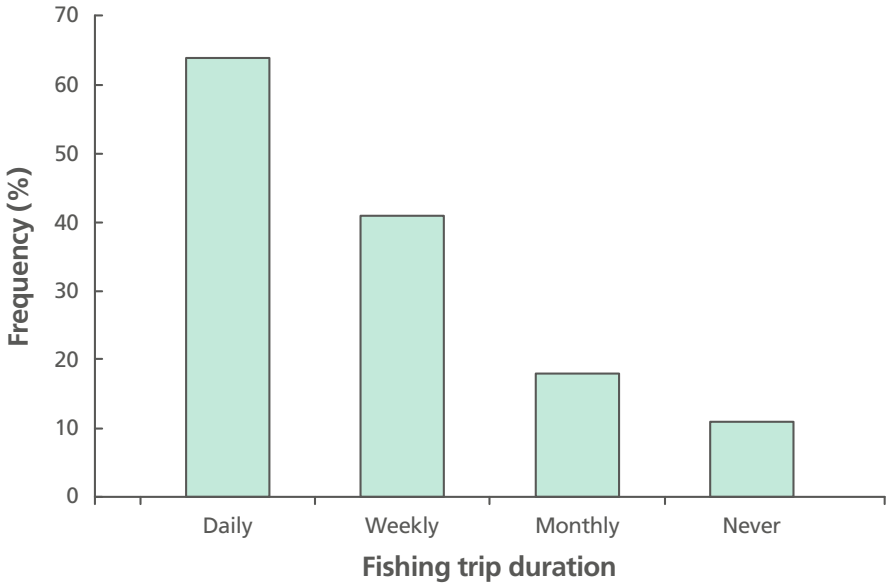
Note: In some instances, households declared that they use their fish only for consumption, for consumption and selling, consumption and sharing, or consumption, selling, and sharing

Figure 15. Fishing gear packed on boat during fishing trips as declared by boat owners during 2019 river monitoring study



Source: Hurtado-Gonzales. 2023. Canada.

Figure 16. Estimated duration of fishing trips during 2019 river monitoring study based on 134 responses



Source: Hurtado-Gonzales. 2023. Canada.

References

Andel, T. 2000. The diverse uses of fish-poison plants in Northwest Guyana. *Economic Botany*, 54: 10.1007/BF02866548.

Conservation International. 2002. *The Kanuku Mountains Protected Area Process: The Community Resource Evaluation Master Report*.

de Souza, L.S., Armbruster, J. W., & Werneke, D.C. 2012. The influence of the Rupununi portal on distribution of freshwater fish in the Rupununi district, Guyana. *Cybium* 36: 31–43. https://doi.org/10.26028/cybium/2012-361-004.

Jafferally, D. 2017. *The implications of changing Makushi identity and traditional practices for forest conservation in Guyana*. PhD thesis, University of London, UK.

Luzar, J.B., Silvius, K.M. & Fragoso, J.M. 2012. Church affiliation and meat taboos in indigenous communities of Guyanese Amazonia. *Human Ecology*, 40(6): 833–845.

Mistry, J., Simpson, M., Berardi, A. & Sandy, Y. 2004. Exploring the links between natural resource use and biophysical status in the waterways of the North Rupununi, Guyana. *Journal of Environmental Management*, 72(3): 117–131.

Mistry, J., Berardi, A. & Simpson, M. 2008. Birds as indicators of wetland status and change in the North Rupununi, Guyana. *Biodiversity and Conservation*, 17: 2383–2409. 10.1007/s10531-008-9388-2.

North Rupununi District Development Board & Iwokrama International Centre for Rain Forest Conservation and Development. 2011. *Building Individual Organisational and Institutional Capacities for Ecological Sustainable Tourism Development and Fisheries Management in the North Rupununi Wetlands Co-Management Plan for Fisheries in the North Rupununi Wetlands*. Guyana. 1–29.

Paemelaere, E.A.D., David, O. & van Vliet, N. 2022. *Guyana: Legal, ecological and socio-economic baseline studies to inform sustainable wildlife management*. Rome, FAO, CIFOR-ICRAF, CIRAD and WCS. https://doi.org/10.4060/cc0031en.

Shephard, S., Edwards, K., George, S., Joseph, E., James, S., David, O., Persaud, A., Watson, L.C. & van Vliet, N. 2022. Community-based monitoring, assessment and management of data-limited inland fish stocks in North Rupununi, Guyana. *Fisheries Management and Ecology*, 30 (2): 1–13. https://doi.org/10.1111/fme.12604

Taphorn, D.C., Liverpool, E., Lujan, N.K., DoNascimiento, C., Hemraj, D.D. *et al*. 2022. Annotated Checklist of the Primarily Freshwater Fishes of Guyana. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 168: 1–95.

Watson, L.C., Stewart, D.J., Clifford, K., Castello, L., Jafferally, D., James, S., Norman, Z. & Watkins, G.G. 2022. Recovery, conservation status, and environmental effects on arapaima populations in Guyana. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 31 (9): 2533–2546.

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Fish are an important food source for the Makushi people

2.4. The use of yellow-spotted river turtle meat and eggs in South Rupununi and prospects for sustainable use

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Highlights

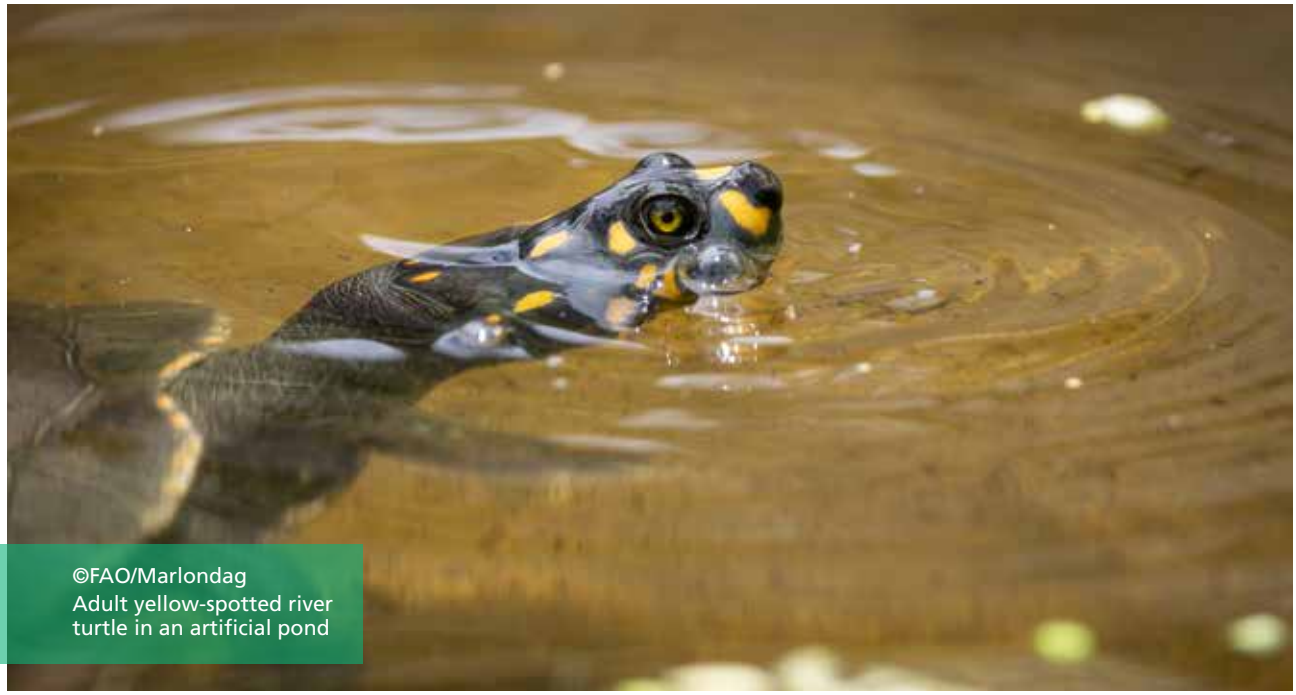
- Approximately 12 percent of households practise egg harvesting, averaging 41.87 eggs per household annually, while 22.4 percent of households capture an average of 3.5 turtles each year.
- Homes with more children tend to consume greater quantities of turtle eggs and meat. Frequent turtle hunting is associated with higher turtle meat consumption.
- Motivations for capture: turtle capture was primarily for consumption during culturally significant events. The primary motivation for turtle harvest is local consumption, followed by local trade, as pets, and for their shells.
- In 2021, the number of eggs consumed locally was 921, while the number of eggs that would have been lost due to flooding was equal to 2 277. This suggests that the rescue of eggs that are at risk of being flooded can help meet local demand without impacting on the turtle population.
- In 2021, 93 turtles were consumed locally, representing 29.3 percent of the adult turtles counted in surveys in 2022–2023. To reduce wild turtle harvests in Sand Creek, it is recommended to preserve a minimum of 204 rescued eggs for hatchlings and extensive farming, thus decreasing pressure on wild adult turtles.
- Monitoring nests and implementing a flood-based rescue programme can shift turtle harvesting from the wild to *ex-situ* hatchling rearing and extensive turtle farming.

©FAO/Luke McKenna
Yupukari wildlife club goes to a beach to rescue turtle eggs

Introduction

The yellow-spotted river turtle (*Podocnemis unifilis*) is a widespread species ranging from the Amazon to Orinoco and Essequibo river basins (Pearse, 2006). During the eighteenth and nineteenth centuries, after a boom in the trade of turtles for their meat, eggs and oil for cooking and urban lighting, turtle populations declined sharply (Casal *et al.* 2013; El Bizri *et al.* 2020a). Despite strict regulations on the use of wild animals in the twentieth century across the Amazon region, high levels of illegal harvesting continued in the absence of adequate enforcement (Kemenes and Pezzuti, 2007; Peñaloza et al., 2013; El Bizri *et al*., 2020). The sale of turtle meat at local markets and the collection of juveniles for the pet trade have a negative influence on yellow-spotted river turtle populations (García-Martin *et al*., 2021). Overall, estimates suggest that populations of the species – which is currently classified as vulnerable (A1acd) by the IUCN Red List (2016), with a recommended revision to be classified as endangered (Rhodin *et al.,* 2018) – may continue to experience severe (more than 50 percent) and rapid (less than 50 years) future losses across 60 percent of the pan-Amazonian range (Norris *et al.*, 2019). Approximately 61 percent of all turtle species are threatened with extinction or are already extinct, and freshwater turtles are one of the most threatened vertebrate taxa (Gibbons *et al.,* 2000).

In many parts of the Amazon, the *P. unifilis* and other Podocnemis species are listed in the top five most preferred taxa in terms of taste, usually, the other animals in this list are mammals (Chaves *et al*., 2019; El Bizri *et al*., 2020b). In the city of Jutaí, Central Amazon, *P. unifilis* was the most expensive (and sold) taxa independent of their sale destination (Hani *et al.*, 2020a). Conversely, another study also conducted in Central Amazon showed that in 2006, 34 tonnes (100 percent) (living biomass) of turtles were acquired by consumers, of which 40.1 percent belonged to *P. expansa*, 38.3 percent to *P. sextuberculata*, and the smaller part (21.6 percent) to *P. unifilis*. In this case, *P. expansa* was also the species of higher market value, having a cost seven times more than *P. sextuberculata* and three times more than *P. unifilis*. Regarding the species whose eggs are preferred in terms of taste, the same study found a higher preference for the eggs of *P. unifilis* (Pantoja-Lima *et al.*, 2014).



©FAO/Marlondag
Adult yellow-spotted river turtle in an artificial pond

In Guyana, the population of *P. unifilis* naturally expands across the Rupununi region, at the headwaters of the Essequibo, Rewa and Rupununi river basins. Makushi and Wapichan communities living in the Rupununi, associate the consumption of the river turtle meat and eggs with special occasions that are part of their cultural heritage. However, there is no detailed quantitative information on the use of turtle meat and eggs in this region. Nevertheless, perceived river turtle population declines over the last 20 years have incentivized local communities to engage in river turtle research and monitoring.

This research aimed to evaluate egg and turtle harvesting practices, as well as the motivations for harvesting. By monitoring nesting sites, we determined the number of eggs that would have been lost to flooding without rescue efforts, and then compared this figure to the eggs consumed locally, offering recommendations for sustainable use. The study also calculated the minimum number of eggs required for artificial hatching and extensive farming to meet turtle meat consumption needs and reduce wild harvesting.

Material and methods

Study site

This study was conducted in Sand Creek, a Wapichan community situated along the Rupununi River in Guyana, whose customary land overlaps with the Kanuku Mountains National Park. The community, with 185 households, traditionally relies on fishing, hunting, farming and fruit tree cultivation, but is gradually transitioning to a cash-based economy, engaging in wage labour, small-scale business, and construction. The region experiences distinct seasons, with a rainy season from May to August causing river flooding, and dry seasons marked by frequent wildfires. Rupununi is home to six freshwater turtle species: the yellow-spotted river turtle, giant Amazon River turtle, painted wood turtle, mata mata, twist-necked turtle, and toadhead turtle.

Data collection

Turtle and egg harvesting interviews

Structured interviews were conducted between December 2020 and January 2021 with 125 households, representing 67.56 percent of the community. The interviews were conducted by local monitors who visited each household, with questions related to socioeconomic characteristics, turtle meat and egg hunting and consumption (harvest frequency and quantities), turtle capturing techniques, and motivation for capturing turtles. Harvesting was not regulated by national park rules.

Nesting monitoring

From January to April in 2022 and 2023, a local monitoring team surveyed nine beaches in Sand Creek. Daily visits occurred from 05.30 to 09.00.

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A young girl eating turtle meat, a festival food for the Makushi people.

©Luke McKenna
The SRCS turtle team from Sand Creek village monitors one of its many beaches

Nests at risk of flooding were identified and then translocated to a hatchery. Data on nest location, temperature, depth and size were recorded.

Count of juvenile and adult turtles

Monitors counted turtles and determined their sex based on facial spots. In 2021, 49 hours and 53 minutes of monitoring were done over 26 days (average 1.9 hours/day, SD = 0.88). In 2022, 56 hours and 49 minutes of monitoring took place over 16 days (average 3.0 hours/day, SD = 1.39).

Data analysis

Generalized linear models (GLM) with a negative binomial distribution were used to analyse the relationship between interviewee characteristics and turtle meat consumption or egg harvesting. No collinearity was observed among predictor variables. Residual checks and the Akaike information criterion were used to assess model suitability and select relevant models. The analysis was performed using R software and relevant packages.

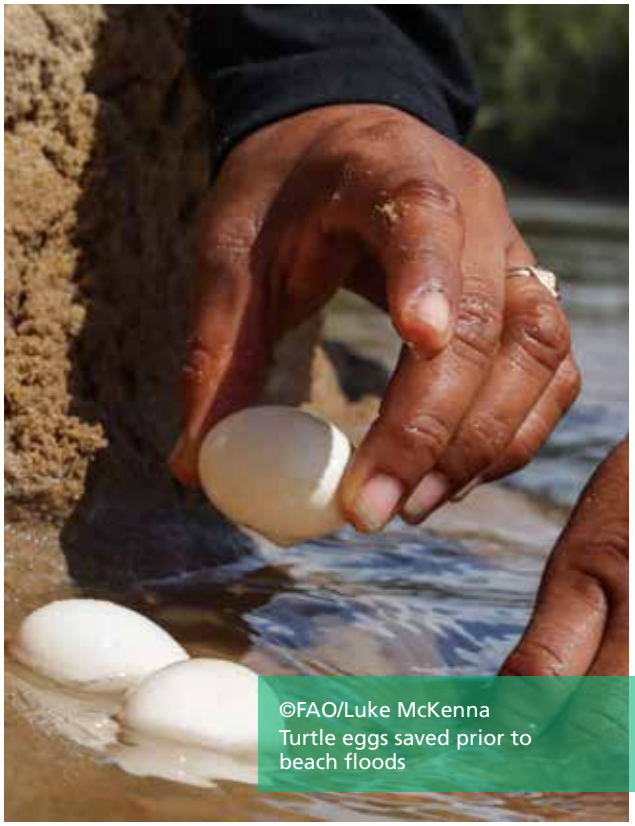
Egg harvest and hatchery calculations

The study calculated the annual average number of eggs that would have flooded per beach if no rescue had taken place and compared it to the average egg harvest per household per year. The number of hatchings needed to meet annual turtle consumption was also calculated, considering mortality in artificial hatcheries and no mortality post-release.

Results

Egg harvesting primarily occurred from December to February, with only 12.0 percent of households (n = 15) engaged in this activity. On average, these households harvested 41.87 eggs per year, with harvests varying from 6 to 180 eggs. The number of eggs harvested was linked to the number of children in each household, being higher in larger families (see Table 13). During the year of the interview, 28 interviewees (22.4 percent) captured a total of 93 turtles (average of 3.5 turtles per household), with a peak in December to February and mainly for special occasions, such as Christmas, New Year celebrations, Easter, and birthday celebrations. Turtle meat consumption was significantly higher in households that hunted turtles (see Table 13). The primary motivation for capturing turtles was for subsistence meat (66.6 percent of households), followed by local meat trade (22 percent), use of the animals as pets (10 percent), and use of the shell. In 2020–2021, 22.4 percent of households had harvested turtles, and 67.2 percent consumed turtle meat. A total of 89 percent of interviewees declared capturing *P. unifilis* exclusively, while 11 percent declared capturing both *P. unifilis* and *P. expansa*.

The study identified 160 and 103 nests in 2022 and 2023, respectively, with an average of 22 eggs per nest. Flooding in 2022 would have affected 2 277 eggs if not for rescue efforts on the monitored beaches. In 2022, monitoring recorded 328 turtle individuals (average of 6.6 turtles per hour) and in 2023, 306 turtles were recorded (average of 5.4 turtles per hour). Of these, 35.3 percent (n = 224) had their life stage and sex identified, including 53.1 percent adult females, 15.6 percent adult males, and 31.3 percent juveniles.



©FAO/Luke McKenna
Turtle eggs saved prior to beach floods

Table 13. Details of the complete model and the null model using a generalized linear mixed model to verify the influence of interviewee characteristics on egg harvesting and the turtle meat consumption rate; the predictor variable showing a significant result is highlighted in bold

Response variable	Predictor variables	Estimate	Std. error	z value	Pr(>|z|)		AIC	AIC null model	ΔAIC
Eggs capture	Male: Female	6.70E-03	1.93E-01	0.035	0.972345		59.42	88.155	28.735
	Age	4.83E-03	5.65E-03	0.855	0.394415				
	# of kids in hh	**1.23E-01**	**3.42E-02**	**3.589**	**0.000484**	***			
	Hunting turtles	2.14E+01	1.35E+03	0.016	0.987403				
	Turtle meat consumption	1.84E+01	1.56E+03	0.012	0.990582				
Turtle meat consumption	Male: Female	0.009234	0.146391	0.063	0.9498		289.61	295.81	6.2
	Age	-0.00015	0.00405	-0.037	0.9706				
	# of kids in hh	**0.023811**	**0.02598**	**0.917**	**0.3612**				
	Hunting turtles	0.382962	0.20166	1.899	0.049	*			
	Turtle meat consumption	0.098318	0.267761	0.367	0.7141				

Source: van Vliet et al. 2023. CIFOR-ICRAF.

Regarding sustainable harvesting, an average of 12 percent of households captured eggs, totalling around 921.1 eggs consumed. This is significantly lower than the potential loss due to flooding. For turtles, approximately 180.4 were captured by 22.4 percent of households. To meet turtle consumption demand and reduce wild harvesting, an estimated minimum of 204 eggs should be hatched in *ex situ* hatcheries and raised in extensive systems.

Conclusions and recommendations

The study confirmed *Podocnemis unifilis* (*P. unifilis*) as the most commonly harvested species, aligning with earlier findings across the broader Amazonian region. The average household harvest stands at 3.5 turtles annually, a value significantly lower than areas with more accessible markets (Peñalosa et al., 2013; Pantoja-Lima et al., 2014; El Bizri *et al.*, 2020b).

Turtle meat and eggs were established as a seasonal food source, with the highest capture rates occurring during the dry season in alignment with local traditions and festivities (Pezzuti *et al.*, 2010; Pantoja-Lima *et al.* 2014). These findings underscore the necessity of integrating cultural considerations into conservation strategies. The study indicated that households with more children exhibited greater consumption, emphasizing the role of turtle products in food security for vulnerable households, as previously highlighted in other studies (Pezzuti *et al*., 2010; Pantoja-Lima *et al.*, 2014).

The rescue of turtle eggs during the seasonal floods of 2021 and 2022 could have met the local demand for eggs and resulted in the conservation of a significant number of hatchlings. It is important to note that floods do not occur uniformly each year, and vary in duration and intensity. Consequently, predicting the precise number of eggs that can be rescued annually remains a challenge. During drier years, the necessity for egg rescue may be minimal, while in years marked by early and intense flooding, the rescue of all nests becomes imperative. It is important to emphasize that while this management approach cannot entirely supplant wild harvest, especially in drier years, it does serve to alleviate pressure during periods of extensive flooding.

The management strategy for hatchlings presents a dual approach: either releasing them into the river

to aid in population recovery, or incorporating them into extensive farming systems within ponds and lakes, effectively reducing the dependence on wild harvest. The propensity for capturing female turtles, owing to their ease of capture during the egg-laying dry season and higher meat yield compared to males, raises concerns about population stability. Thus, implementing a farming strategy would ensure the long-term sustainability of turtle populations while preserving cultural traditions (Chaves *et al.*, 2018). This approach, demonstrated in various regions, involves establishing extensive turtle farming units that necessitate vigilant attention to the turtles' nutrition, welfare and protection against predation (Brasiliense *et al.,* 2023). With an estimated maturity age for *P. unifilis* ranging from three to nine years (Peñalosa *et al*., 2013), extensive turtle farms can effectively meet the demand for turtle meat, particularly during cultural events.

In Guyana, where the species is not on the protected species list and is not regulated by harvest quotas at the national level, it is crucial to develop community-driven sustainable use systems that harmonize traditional subsistence practices with conservation efforts. Monitoring of turtles and turtle trade together with *in situ* and *ex situ* protection and harvest rules, should help reduce pressure on the species, specially in light of the increased market access as expected in the region with economic development. Successful wildlife conservation is intricately tied to both economic benefits and the intrinsic values held by local communities (Campos-Silva *et al.*, 2020). Therefore, management strategies that acknowledge the cultural significance of turtle consumption and the essential roles of subsistence and income, like those discussed in this study, are more likely to endure and be embraced by successive generations within the community.

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Yellow-spotted river turtles basking in the sun during the day

References

Alho, C.J.R. 1985. Conservation and management strategies for commonly exploited Amazonian turtles. *Biological Conservation* 32: 291–298. https://doi.org/10.1016/0006-3207(85)90019-9.

Brasiliense, A.R.P., Mendonça, R.P., de Almeida, P.E.M., Damasceno, L.F., Hoshino, M.D.F.G. & Yoshioka, E.T.O. 2023. Different dietary protein levels for *Podocnemis unifilis* subadult farming: Hematological and biochemical assessment. *Journal of Applied Aquaculture*, 35:3:674–686. https://doi.org/10.1080/10454438.2021.2016544

Alho, C.J.R. 1985. Conservation and management strategies for commonly exploited Amazonian turtles. *Biological Conservation* 32: 291–298, https://doi.org/10.1016/0006-3207(85)90019-9.

Campos-Silva, J.V.J.E., Hawes, P. C. M. Andrade, P.C.M. & Peres, C.A. 2018. Unintended multispecies co-benefits of an Amazonian community-based conservation programme. *Nature Sustainability,* 1(11): 650–656.

Cantarelli, V. H., Malvasio, A. & Verdade, L.M. 2014. Brazil's *Podocnemis expansa* conservation program: retrospective and future directions. *Chelonian Conservation Biology*, 13: 124–128.

Casal, A.C., Fornelino, M.M., Restrepo, M.F.G., Torres, M.A.C. & Velasco, F.G. 2013. Uso Histórico y Actual de las Tortugas Charapa (*Podocnemis expansa*) y Terecay (*Podocnemis unifilis*) en la Orinoquia y la Amazonia. *Biota Colombiana*, 14: 45–64.

Chaves, W.A., Valle, D.R., Monroe, M.C., Wilkie, D.S., Sieving, K.E. & Sadowsky, B. 2018. Changing Wild Meat Consumption: An Experiment in the Central Amazon, Brazil. Conservation Letters, 11: e12391. https://doi.org/10.1111/conl.12391

Peñaloza, C.L., Hernández, O., Espín, R., Crowder, L.B. & Barreto, G.F. 2013. Harvest of Endangered Sideneck River Turtles (*Podocnemis* spp.) in the Middle Orinoco, Venezuela. *Copeia,* 2013(1): 111–120, (27 March 2013).

El Bizri, H.R., Morcatty, T.Q., Valsecchi,J., Mayor, P., Ribeiro, J.E., Vasconcelos Neto, C.F. & Oliveira, J.S. *et al*. 2020. Urban Wild Meat Consumption and Trade in Central Amazonia. *Conservation Biology*, 34: 438–448.

El Bizri, H.R., Morcatty, T.Q., Ferreira, J.C., Mayor, P., Vasconcelos Neto, C.F.A., Valsecchi, J., Nijman V. & Fa J.E. 2020b. Urban Wild Meat Consumption and Trade in Central Amazonia. *Conservation Biology*, 34: 438–448. https://doi.org/10.1111/cobi.13420

Fisheries (Aquatic Wild Life Control) Regulations. 1966 (Regulations No. 3). Guyana

García-Martin, A., El Bizri, H.R., Vasconcelos Neto, C.A., Nijman, V. & Fa, J.E. 2021. Social and Biological Correlates of Wild Meat Consumption and Trade by Rural Communities in the Jutaí River Basin, Central Amazonia. *Journal of Ethnobiology.*

Gibbons, J.W., Lovich, J.E. & Bowden, R.M. 2000. Extinction vortex in a herpetofaunal assemblage. *Biological Conservation*, 92(1): 85–95.

Kemenes, A. & Pezzuti, J.C.B. 2007. Estimate of trade traffic of *Podocnemis* (Testudines, Pedocnemididae) from the Middle Purus River, Amazonas, Brazil. *Chelonian Conservation and Biology*, 6(2): 259–262.

Murrieta, R.S.S. 1998. O dilema do papa-chibé: Consumo alimentar, nutrição e práticas de intervenção na Ilha de Ituqui, baixo Amazonas

Norris, D., Peres, C.A., Michalski, F. & Gibbs, J.P. 2019. Prospects for freshwater turtle population recovery are catalyzed by pan-Amazonian community-based management. *Biological Conservation*, 233: 51–60.

Pantoja-Lima, J., Aride, P.H., de Oliveira, A.T. *et al*. 2014. Chain of commercialization of *Podocnemis* spp. turtles (Testudines: Podocnemididae) in the Purus River, Amazon basin, Brazil: Current status and perspectives. *Journal Ethnobiology Ethnomedicine*, 10(8): https://doi.org/10.1186/1746-4269-10-8

Pearse, D.E. 2006. Estimating population structure under nonequilibrium conditions in a conservation context: Continent-wide population genetics of the giant Amazon river turtle, *Podocnemis expansa*. *Molecular Ecology*, 15(4): 985–1006.

Pezzuti, J.C.B., Pantoja-Lima, J., Félix-Silva D. & Begossi A. 2010. Uses and taboos of turtles and tortoises at Negro River, Amazonas. Brasil. Journal of Ethnobiology 2010,30(1):153–168. 10.2993/0278–0771-30.1.153

Rhodin, A.G.J., Agha, M., Amato, G., Buhlmann, K.A., Bour, R., Fritz, U. *et al*. 2018. Global Conservation Status of Turtles and Tortoises (Order Testudines). *Chelonian Conservation and Biology*, 17: 135–161.

2.5. Wildlife-based tourism in the Rupununi

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Highlights

- Rupununi's wildlife tourism industry has become a significant economic engine, benefiting local communities and incentivizing the protection of wildlife and habitats.
- While tourism offers many benefits, it can also have negative impacts on wildlife, and it is crucial to address those to ensure sustainable tourism practices in the region.
- Since the 1920s, numerous private and community-based ecotourism initiatives have emerged in the region, offering a variety of consumptive and non-consumptive wildlife-based tourism products.
- Visit Rupununi (VR) and the Sustainable Wildlife Management (SWM) Programme are working together to promote best practices and develop a common vision for wildlife-friendly tourism in the region.

Introduction

The Rupununi's exceptionally biodiverse territory makes it an excellent destination for wildlife-based tourism. Historically, tourism in the region has been a small industry, targeting mainly foreign visitors, but the growing demand for experiences that combine wildlife watching with cultural activities is cre-

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A tourist goes on an evening horse ride looking for wildlife

ating opportunities that benefit local communities. Now a purring economic engine, the industry not only creates employment opportunities in rural villages where jobs are scarce, but it also incentivizes the protection of birds and animals that visitors will pay to see, such as giant otters, giant anteaters and jaguars. Beyond the economic benefits for the local economy, wildlife-based tourism can also represent an alternative to wildlife hunting and trade, as it may generate more revenue while reducing pressure on wildlife. The tourism sector can also increase the economic value of wildlife-friendly landscapes and reduce the likelihood of conversion to less-sustainable uses of land, such as agribusiness, mining and logging.

Tourism, while offering many benefits, can also have negative impacts on wildlife, and these impacts can vary depending on factors such as the destination's vulnerability, the type of tourism activity, the number of tourists visiting the site, their behaviour, and the carrying capacity. The main direct impacts on wildlife include disturbance of animal behaviour, changes in feeding and breeding patterns, increased vulnerability to competitors and predators, disruption of parent-offspring bonds, transmission of diseases, collection of eggs, and captivity for pet trade. Other negative effects linked to wildlife tourism include poaching, human–wildlife conflict, habitat loss, littering and poor waste management, both solid and liquid. Changes in behaviour and relationships with expanding human infrastructure are also likely to result in an increasing rate of road collisions. Local leaders in the Rupununi caution that while better roads are likely to support the tourism market – in particular, from Brazil – road construction or improvements must be planned carefully to avoid damaging ecosystems and wildlife habitat (see Chapter 3.2), as well as to prevent annual flooding and disruption to fish spawning.

As tourism in the Rupununi continues to grow, it has become increasingly important for tourism operators to address the potential negative impacts on wildlife, the natural environment and the local culture. To ensure that tourism in the Rupununi is sustainable, Visit Rupununi (VR), a grassroots umbrella organization for tourism in the Rupununi, has partnered with the SWM Programme to promote best practices and develop a common vision for wildlife-friendly tourism.

This chapter provides an overview of the history of tourism in the Rupununi, highlights the current tourism services available in the region, and showcases the collaborative efforts of VR, comprising members from diverse sectors, in laying the groundwork for a charter to steer the sustainable development of Rupununi tourism.

History and evolution of tourism in the Rupununi

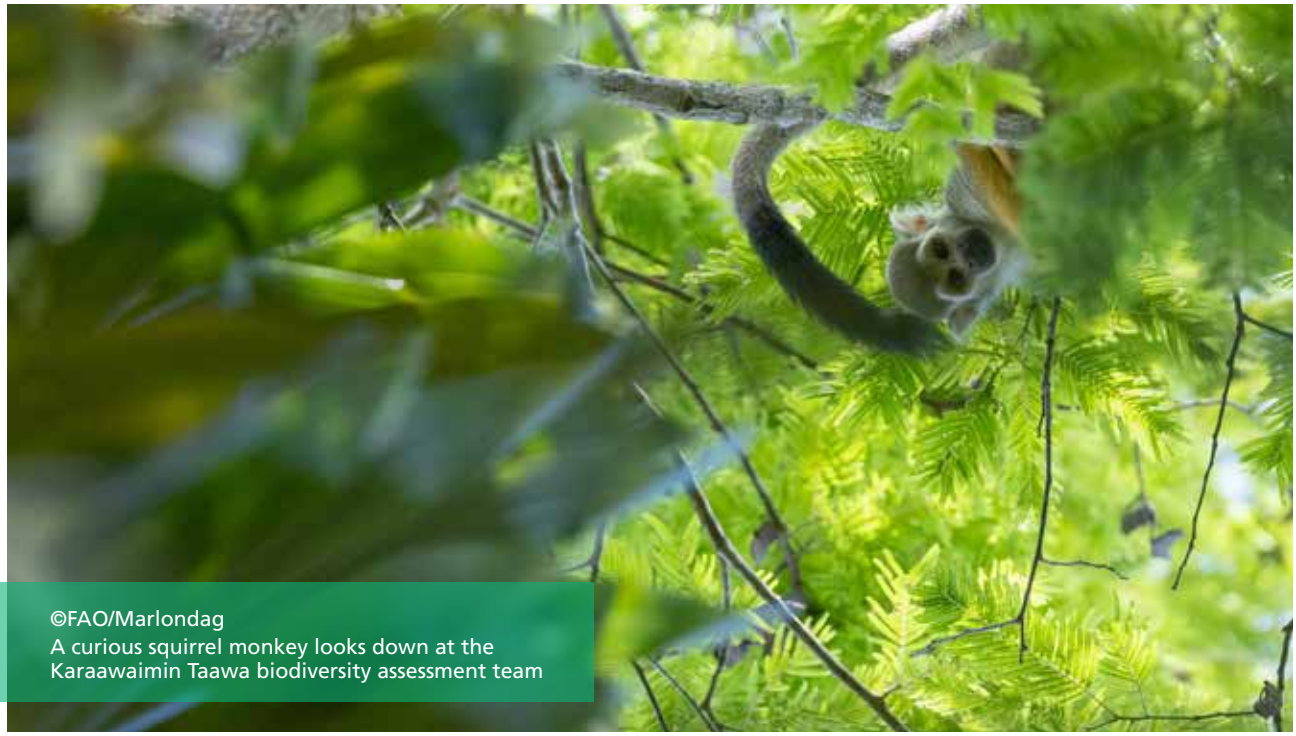
Tourism in the Rupununi initially began when land-holding families launched "Ranches of the Rupununi", a tour package that combined home stays with nature tourism, mainly catering to diplomats from Georgetown and, later, scientists doing research in the region. Karanambu Ranch, established in 1927, was part of this initiative, but it also established a conservation trust focused on protecting the area's giant otters, which were heavily hunted for their pelts in the 1960s and 1970s. The work initiated by Karanambu Lodge with giant river otters was the first conservation project in the region and helped raise awareness for their conservation. Tourism was a significant contributor to supporting these efforts. The establishment of the Karanambu Trust in 1997 also saw the creation of Guyana's first private protected area. In collaboration with the surrounding villages, the 323-km^2 area of Karanambu was set aside as a reserve within which hunting, trapping and the use of nets was prohibited, substantively lending protection to breeding populations of numerous wildlife and critical spawning grounds.

In Surama, the community-based tourism business started in 1998 with just 50 annual visitors, but has since grown to attract more than 2 000 visitors each year. As a result of this achievement, the village established a 419.2-ha wilderness reserve for the conservation, protection and preservation of the natural environment, providing

economic, social, spiritual and cultural benefits for the people of Surama through ecotourism. Today, the reserve area is home to many bird species including the mighty harpy eagle (*Harpia harpyja*), Guianan cock-of-the-rock (*Rupicola rupicola*), and rufous-winged ground cuckoo (*Neomorphus rufipennis*). Mammals in the reserve include tapir (*Tapirus terrestris*), capybara (*Hydrochoerus hydrochaeris*), jaguar (*Panthera onca*), giant armadillo (*Priodontes maximus*), giant otter (*Pteronura brasiliensis*), red howler monkeys (*Alloutta seniculucs*), capuchin, and many snakes, fish and spiders. Trapping of wildlife has been banned in the whole area since 1992, soon after the sun parakeet (*Aratinga solstitiaslis*) disappeared.

Another successful example of community-based wildlife-based tourism is Rewa Eco-Lodge. In the homonymous village of Rewa, poor job security led villagers to illegally harvest and trade wild animals. As a result, wildlife species such as arapaima, giant river turtles and giant otters were beginning to disappear. In 2005, the village opened a community-run ecolodge with beneficiary funds from Conservation International. The lodge aims to improve livelihoods while protecting ecological diversity. Since 2011, thanks to the support of the Guyana Tourism Authority (GTA), Compete Caribbean and Costa Del Mar, it also started to offer catch-and-release sport fishing for arapaima. Based on experience and research, simple guidelines have been developed to ensure that the species can be released safely, thereby ensuring the continuity of the business while preserving the ecological diversity of the region.

Simultaneously, Yupukari village became involved in caiman research. In 2005, researchers from the Bronx and St Louis zoos in the United States built Caiman House in Yupukari as a field station for their study of the black caiman in the adjacent Rupununi River. The research station evolved as a non-profit lodge owned and managed by the Yupukari community, serving as the cornerstone for a social enterprise effort that includes nature conservation, education, economic development, cultural preservation and tourism. Caiman House, which won the prestigious Caribbean Excellence in Sustainable Tourism Award in 2012, also pioneered conservation work on yellow-spotted river turtles (*Podocnemis unifilis*).



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A curious squirrel monkey looks down at the Karaawaimin Taawa biodiversity assessment team

Meanwhile in the South Rupununi, a research expedition was astonished to encounter red siskins 900 km away from the nearest known population. The scientific discovery of this bird in Guyana generated local and international interest, leading to the development of well-established birdwatching tourism in the region. National organizations, such as the GTA, have recognized the South Rupununi Conservation Society (SRCS), established in 2002 by local bird guides, for its efforts in promoting the South Rupununi and the red siskin tourism package nationwide. In 2020, with support from the SWM Programme, the red siskin range was identified and subsequently officially recognized as Guyana's first 'Important Bird Area'. Since then, a community-managed conservation area was established over the entire Rupununi range of the red siskins.

In 2019, with support from the SWM Programme, the SRCS established a research project on anteaters at Wichabai Ranch, a lodge that was, at that time, recently established. The research on anteaters was carried out with support from community members, and soon developed into the establishment of a community anteater conservation zone in four communities. In parallel, Wichabai Ranch increasingly benefited from tourism, attracting visitors that could participate in setting camera traps to track anteaters and other large mammals and, if lucky, observe anteaters at close proximity to the lodge.

The successful introduction of ecotourism as an alternative livelihood and income-generating opportunity in the region has led to the development of several other community-based conservation and management initiatives, which illustrate the inextricable link between tourism and wildlife conservation in the region. In 2010, Conservation International Guyana, in partnership with the Inter-American Development Bank (IDB), published a seminal study entitled *Community tourism enterprise development in the Rupununi: A blueprint*. This study assessed the current rate of community tourism marketing and development, and provided several recommendations for individual and regional tourism support and development.

At the time of publication, 11 lodges were operating in the Rupununi and the following areas were identified as requiring most urgent support: 1) training and capacity building; 2) marketing,

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Community-run eco-lodge in Rewa Village.

promotion and dissemination of information; and 3) a local business representation or in-bound operators for the Rupununi. In 2018, VR, with support from SWM, carried out the most recent needs assessment based on the criteria and indicators of the community-based tourism standard, simplified and adapted to the Rupununi. From the needs expressed by the 19 lodges active in the region, a list of the top tangible actions was developed, including: 1) training on several topics such as community-based tourism standards, digital marketing, business-plan development, catering, safety, tour guiding, record-keeping and pricing; 2) improved marketing of the services offered in the Rupununi; and 3) improved networking with the nature-based tourism industry. In addition, VR identified the need to develop guidelines for wildlife-friendly tourism operations to ensure they continue to operate and grow without becoming a threat to wildlife and natural habitats.

Tourism in the Rupununi largely contributes to the shared vision 2025 for Guyana, which is to be recognized as a premier destination for protecting its natural and cultural heritage, providing authentic experiences and maximizing benefits to local residents. The Rupununi region's tourism sector also largely contributes to the national economy. At the national level, tourism is the second largest export sector, generates an estimated 22 000 jobs and about USD 300 million directly into Guyana's economy (Mullis *et. al.*, 2023).

Wildlife at the heart of tourism offered in the Rupununi

In 2021, VR conducted a brief study that revealed the two most popular attractions among tourists and visitors in the Rupununi: the landscape/scenery and wildlife/nature. In addition, several tourists expressed interest in experiencing more of the Indigenous communities, including traditional crafts, foods and Amerindian heritage. This highlights the growing demand for wildlife-based tourism in the Rupununi, as well as the desire among visitors to connect with and learn about the local culture and traditions.

"Wildlife-based tourism products" is a broad term that includes consumptive and non-consumptive wildlife tourism activities that contribute to conserving the environment, protecting wildlife and

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Tourists enjoying some early morning bird watching

improving the well-being of people. The term is used to describe an extensive range of activities in which tourists travel to natural areas to appreciate and enjoy wildlife.

Wildlife tourism includes:

- **Non-consumptive wildlife tourism:** This refers to activities that involve observing, appreciating and experiencing wildlife and their natural habitats without causing any harm or disruption to the animals or their environments. Examples include birdwatching, photographic and walking tours, and observations of rare, endemic species or species that are part of a conservation project, such as turtles.
- **Consumptive wildlife tourism:** This refers to activities that involve harvesting or use of wildlife for commercial or recreational purposes, often resulting in the death or removal of the animals from their natural habitats. Examples include trophy hunting, sport fishing (excluding catch and release), production of handicrafts, and local cuisine of wild meats and fish.

Wildlife-based products in the Rupununi include both consumptive and non-consumptive uses of wildlife. They can be classified as follows:

Non-consumptive

Wildlife spotting: Wildlife spotting is the most important wildlife-based tourism product in the Rupununi. Endemic and rare birds such as red siskin, harpy eagle, sun parakeet, cock-of-the-rock, rufous-winged ground cuckoo (*Neomorphus rufipennis*) and capuchin bird (*Perissocephalus tricolor*) are among the most sought-after, along with giant anteaters, black caimans and giant river otters. Birdwatching, in particular, is the oldest and most developed tourism product offered in the Rupununi. Wildlife spotting can take place in a variety of habitats, including forests, savannahs, rivers and creeks, bush islands, and even caves and rocks depending on the targeted species. Walking tours, horseback riding, car drives and canoe or boat trips are all popular ways to spot wildlife. Although certain species may be advertised more heavily, other wildlife can also be seen during spotting trips: for example snakes, capybaras, monkeys, agoutis, tamanduas (*Tamandua tetradactyla*), savannah deer, tapirs and jaguars.

Catch and release: Sport fishing is a growing business in the Rupununi, and is offered by lodges like the Rewa and Apriabo lodges, as well as in the form of organized trips by outfitters like King Solomon

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A visitor experiences how to make cassava bread with a local Wapichan family

Adventures and others. The most successful example of the introduction of sport fishing has been in the community of Rewa, where catch and release for the arapaima comes at a premium price and has successfully transformed a community of arapaima hunters into the guardians of their former prey.

Consumptive

Wildlife-based handicrafts: Handicrafts made by Indigenous communities constitute a source of income, particularly for elderly women. The handicraft industry uses a large variety of non-timber forest products, including wildlife-based products such as leather to make belts, hats and even horse-riding equipment; and feathers, for earrings, necklaces and other jewelry. Massara village in the North Rupununi is best known for its embroidery of traditional and nature scenes. In Surama, jewelry from seeds and embroidery also revolve around local culture and wildlife, as do the balata (rubber) figures from Nappi. Parishara produces carved wood products from the letterwood tree (*Piratinera guianensis*). Near Lethem, in the villages of Kumu and St. Ignatius, handicrafts focus on cotton and feathers. Feathers have traditionally been part of headdresses, but there are legal restrictions on exporting them. In the south, Aishalton and Sand Creek are active in handicrafts, as is the Wai Wai. Leather products made from wildlife, such as jaguar, are typically restricted to heritage regalia, although their market is declining, particularly among Makushi. Claws and teeth of jaguars and caiman are seen in pendants, but rarely sold.

Wildlife-based cuisine: Local fish meals are regularly offered in lodges. Typical fish meals include lukunani, tiger fish or piranha, and are often served with farine, a traditional granular starch product made from the bitter cassava. While some wildlife products are not necessarily developed for tourism purposes, they may be offered during the tourism experience. For example, wild meat is served in two community-based lodges and in some traditional events that usually attract tourists, such as those organized for Heritage Month or the Rupununi Rodeo. However, in general, wild meat is not promoted locally as a tourism product and, when on the menu, is presented as part of a cultural experience linked to the traditional Indigenous lifestyle.

Wildlife conservation/research and tourism activities: Yupukari village is an example of one community that has been able to leverage its conservation projects effectively to sustain a profitable tourism product. Initially through the Caiman Project, a community-led research initiative on caimans of the Rupununi River, Yupukari started offering tourists the opportunity to join researchers conducting studies on black caiman. The growing popularity of the caiman experience allowed local researchers to continue their study beyond the original period of funding and to support the induction of a second conservation project that engaged the community even more widely: the programme for turtle rearing and reintroduction. Yupukari has also developed the popular Turtle Festival, which, in 2020, was recognized by VR for its significant contribution to both conservation and tourism in the region.

At Wichabai Ranch, tourism and conservation are seen as linked and interdependent. Many tourists travel to Wichabai to see giant anteaters and red siskins. Visitors might also post on social media about their experiences, raising the profile of the two species. In addition, the tourists often give a small donation to SRCS, which is based at Wichabai, allowing further research and monitoring work. As this work continues and is further publicized, it attracts more tourists and the cycle continues with possibilities of expanding the work of SRCS to protect other threatened species. Wichabai Ranch also allows researchers to stay and collaborate with SRCS, thereby increasing the skills of the rangers and the capacity of the organization.

Rewa is home to the international arapaima conservation research programme. This has drawn attention to Rewa, and the Rupununi in general, as an important site for conservation through various media outlets. Karanambu has had a longstanding programme on otter rehabilitation and release. Iwokrama, Surama, Karanambu and Yupukari all receive

international student groups for research projects.

Trophy hunting: Trophy hunting is not a product on offer in the Rupununi and is generally not supported by local stakeholders.

Tourism stakeholders in the Rupununi

Communities: Some villages in the Rupununi (e.g. Wowetta, Surama, Sand Creek and Karasabai) have established tourism committees that manage community-based tourism at the village level in close relation with the village council. Generally composed of five people (chair, vice chair, treasurer, secretary and assistant), and accompanied by representatives of the different tourism-related groups (tour guides, bird guides, culture, crafts, youth, agroprocessing, catering, accommodation), the tourism community is in charge of developing the local tourism strategy and policy, and its action plan or tourism master plan. It defines the tourism products to be developed and sets rules and regulations in terms of sustainable natural resources and environmental management, conservation of cultural heritage, as well as carrying capacity. Committees are formed to organize special events, such as Indigenous Heritage Month celebrations and the Rupununi Rodeo.

Private lodges and tourism providers: A relatively new trend is private lodges and bed and breakfast sites. Rock View (Annai) is a private lodge that was established in 1992. More recent additions are the Pakaraima Mountain Inn (Yakarinta) and New Views (Shulinab). These are not community-owned accommodation, but rather, they are run by private individuals. Some ranches also function more in this capacity, rather than as a working ranch (e.g. Karanambu, Manari), drawing most of their income from tourism and not from cattle.

Some tourism providers do not offer lodging, but provide activities and meals. A few private ranches in the region have chosen to diversify their business model and offer the 'vaquero' experience to their visitors. Most of these ranches offer lodging facilities and horseback riding, birdwatching or anteater spotting as part of the experience (for example, Saddle Mountain, Karanambu, Wichabai, Dadanawa).

Local tour operators: Adventure and waterfall tours are offered by local tour operators (Rupununi River Drifters, Rupununi Trails, Untamed Adventures, Bush Masters, Sky Valley Tours, for example). Speciality birding expeditions are among the region's most lucrative offerings, attracting international birding groups to a range of sites across the region. These are provided by private outfitters and speciality guides (Ron Allicock Travel and Tours, Rupununi River Drifters, Guyana Truly Wild, Leon Moore Nature Experience, for example) while herpetology and entomology tours are offered by Green Diamond Nature Tours. Some villages offer tours, even if they do not have lodging for guests, such as Wowetta and Shulinab. Some communities have MoUs with private individuals within the community who operate specific sites (e.g. Kumu, Moco-Moco, Ariwa Beach, Katoka). Additionally, there is a small group of private guides that organize tours, such as hiking trips and waterfall excursions, predominantly for domestic versus local tourism and cross border visitors from Brazil.

Support services

4X4 vehicle operators: With its untamed terrain and seasonal roads, the Rupununi depends on reliable transportation services as an integral link between the region's main airport in Lethem and the region's most visited tourism sites, which can be in the range of one- to five-hours' travel time. This has led to the emergence of the industry subsector of 4x4 vehicles and select minibus operators who specialize in safe transport between locations and from Lethem to tourism destinations across the region.

Eateries: Increased business and domestic operations within the region have led to the development of small restaurants and snackettes along the length of the main Rupununi roads with a focus in Annai and Lethem. Serving miners, minibus travelers and local communities, these eateries have reported increased numbers of domestic travellers exploring the region. They often see significant

©Luke McKenna
The Karao Culture Group Dancers

numbers of consumers during festival periods, such as Heritage Month or the Rupununi Rodeo. This has led to an increased demand for wildlife and fish, though consumption of wild meat is discouraged and rarely on offer.

Governmental bodies: The GTA, which operates under the Ministry of Business, is a semi-autonomous governmental organization. Established on 11 June 2002, GTA's mission is to develop and promote sustainable tourism in Guyana through collaboration to maximize local socioeconomic and conservation outcomes and improve the visitor experience. More recently, GTA has extended its mandate to developing and promoting community-based tourism, which has led to increased investment in project support and training targeting Indigenous communities. The Regional Democratic Council (RDC) also supports the regional mandate for tourism development. It helps communities to implement and source funding for tourism projects articulated within community development plans. With the support of RDC, VR has been acknowledged as the regional tourism body for the Rupununi region. Furthermore, the Ministry of Amerindian Affairs, through its community development officers, supports communities in project development and funding.

Local grassroot NGOs: These are also major actors in the tourism sector. The North Rupununi District Development Board (NRDDB) is a community NGO composed of 16 out of 20 communities of the North Rupununi region, and has within its mandate direct support to tourism development in interested communities such as Surama, Rewa and Yupukari. Under the NRDDB, the Binna Hill Institute for Youth Development offers certificate programmes in tourism and conservation. The NRDDB has, for over 20 years, supported a series of wildlife clubs for youths in each community, promoting knowledge and understanding of conservation issues. Many of these youth go on to work in ecotourism as guides, hospitality staff and research assistants. In the South Rupununi, the SRCS consists of citizens from different villages engaged in conservation efforts. While SRCS is a conservation organization, its members are tour guides in wildlife tourism. They formed a conservation organization originally to study the en-

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"Keep the Rupununi wild", a campaign by Visit Rupununi to encourage wildlife friendly behaviours

dangered red siskin, but now fulfil a general role in conservation research, applications and education. Caiman House Inc. is a community-managed NGO based in Yupukari village. It is involved in research, conservation and tourism, particularly focused on black caiman, river turtles and environmental education.

Rupununi wildlife-friendly guidelines

In 2021, to promote a wider understanding of the significance of the role of wildlife in tourism in the Rupununi, members of VR, with support from SWM, developed a wildlife-friendly tourism manual. The manual is the first step towards the goal of creating a charter to guide the development of Rupununi tourism, and institutionalizing its commitment to "Keep the Rupununi Wild" while fostering responsible economic growth across the region.

The guide was written and edited by members of VR from community-based and private lodges, villages, ranches and conservation groups. It is intended for use by all tourism operators existing and new to the Rupununi tourism landscape, established businesses as well as individuals.

The Visit Rupununi Wildlife Friendly Tourism guide contains 13 commitments:

1. We learn about, follow and encourage respect for local customs and rules.
2. We protect natural habitats from destructive human disturbance.
3. We do not disrupt or upset the birds, animals or plants that we show our guests.
4. We do not use, serve or sell wildlife, wild meat, crafts or other items from unsustainable sources.
5. We do not promote hunting for sport.
6. We reduce harm in catch and release when sport fishing.
7. We do not have animals in captivity for the purpose of tourism.
8. We include nature, energy efficiency and sustainability in the design of our facilities and services.
9. We reduce and mitigate our generation of waste, use of fossil fuels and use of harmful chemicals.
10. We share our local and scientific knowledge with

our guests, colleagues and communities.

11. We contribute to conservation, research and education.
12. We monitor our impact on the environment to ensure we are contributing to positive change.
13. We bring benefits to our communities and encourage local people to practise wildlife-friendly behaviours.

Based on the above 13 commitments, VR also introduced a certification process in 2023, by which individual locations and businesses working in the tourism value chain in the Rupununi could be certified as 'Wildlife Friends' based on their commitment and level of adoption of the charter.

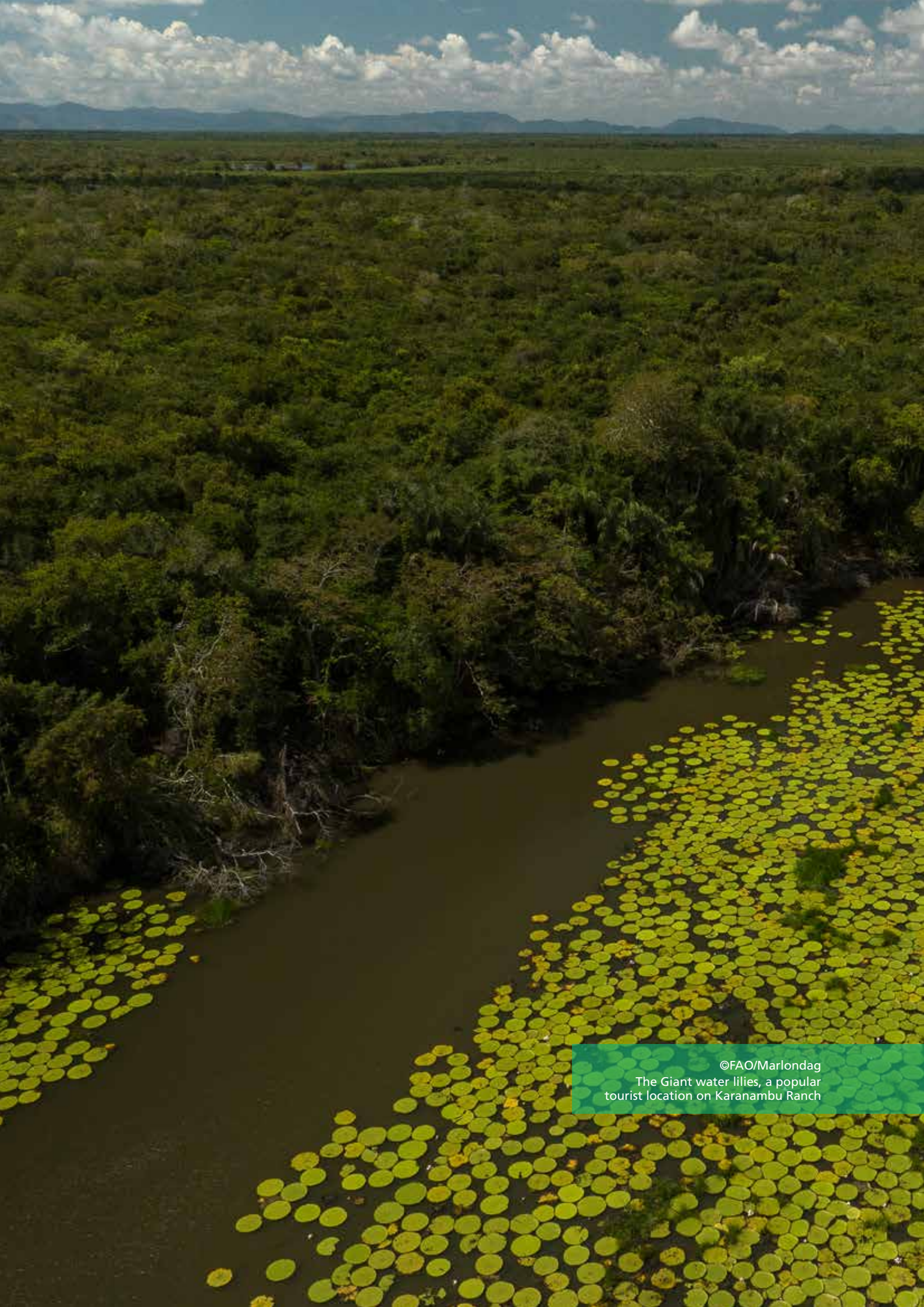
Conclusion

Wildlife-based tourism has the potential to be a major driver of economic growth and environmental conservation in the Rupununi. While the sector is still in its early stages, there have been significant efforts to develop and promote it from a wide variety of community and private stakeholders. However, it is essential that any development of this industry is done in a sustainable and responsible manner that respects the delicate balance of the local ecosystem, supports the livelihoods of local communities and remains sensitive to the unique cultural landscape of the region. This is particularly important in view of the continued growth of the tourism industry in the Rupununi and the increasing political pressure placed on the region to engage with external investors to upscale use of its natural resources. With the right support and management, wildlife-based tourism can be a significant source of income and employment while also contributing to the conservation of the region's unique natural and cultural heritage.

Reference

Mullis, B.T., Balcam, N. & Cameron, S. 2023. Sustaining Nature's Beating Heart—Guyana: Becoming a Leading Sustainable Destination. Sustainable Tourism in the Americas, 149.

©FAO/Marlondag
A tourist visits Karanambu Ranch to enjoy the wildlife tourism on offer.



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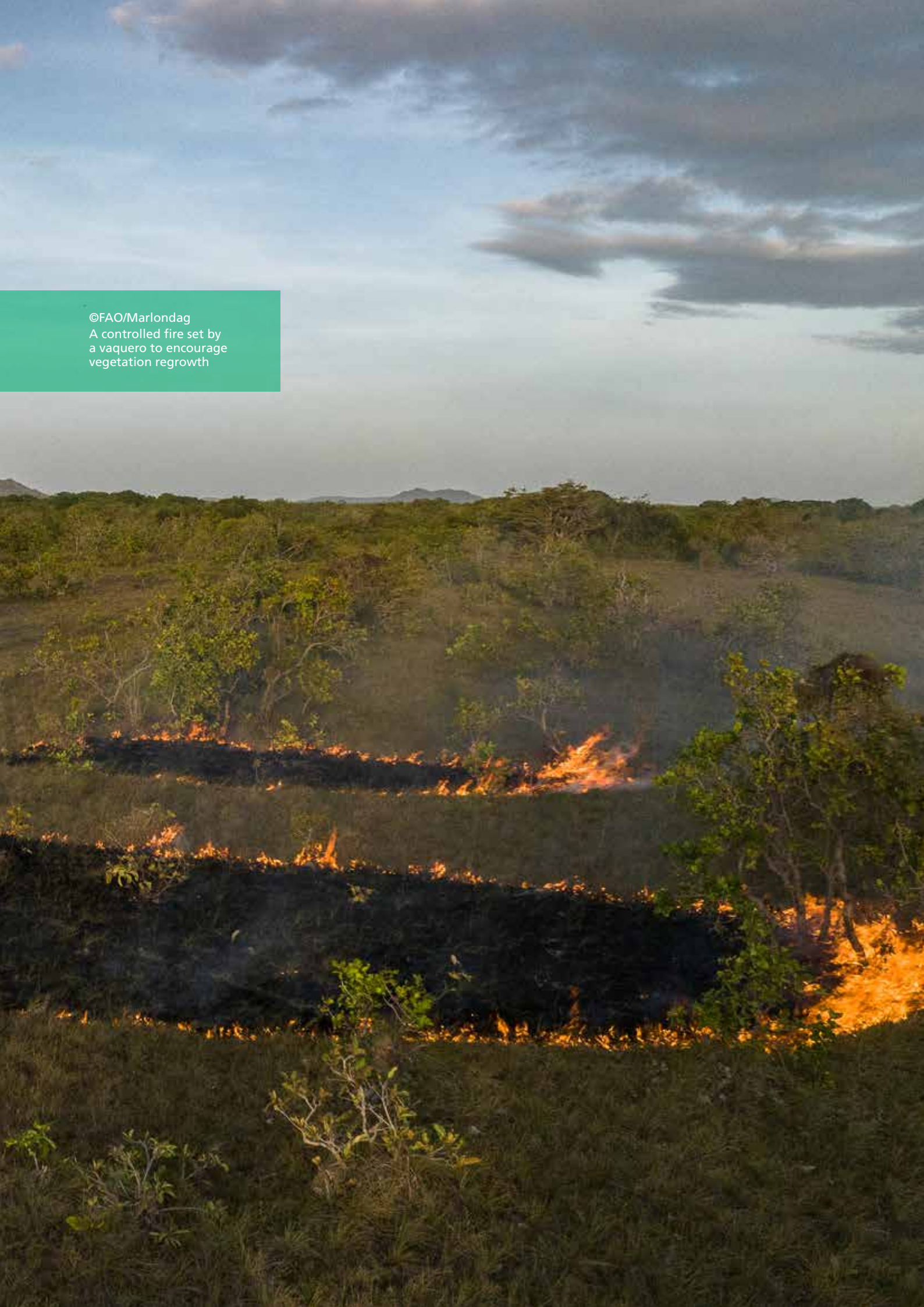
The Giant water lilies, a popular tourist location on Karanambu Ranch



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A controlled fire set by a vaquero to encourage vegetation regrowth

3. Coexistence between humans and wildlife in the Rupununi

3.1. Bird and mammal responses to fire in the Rupununi savannah

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Highlights

- Fire plays a crucial role in the livelihoods of Indigenous Peoples of the Rupununi region, serving various purposes such as safeguarding livelihoods, encouraging vegetation growth, supporting hunting and managing cattle.
- This study aims at investigating the short-term impact of fire on medium to large mammals and birds in the Rupununi.
- We found that mammal species diversity was not affected significantly by the frequency of fire. The number of mammal live sightings decreased shortly after a fire, but then increased to a peak 50 days after a fire before decreasing again.
- Nine-banded armadillos and savannah foxes showed a positive relationship with fire frequency and were commonly detected on burn scars. On the other hand, tapir was significantly less abundant in more frequently burnt areas.
- We also found that fire had a short-term suppressive effect on the diversity and abundance of most bird species; however, substantial recovery occurred as little as two weeks after a fire.
- Three species of raptors – savannah hawk, crested caracara and white-tailed hawk – were detected with much greater frequency, and in greater numbers, in active burns than in post-fire habitats. Five species showed a notable preference for habitats that had been recently burnt, including the white-chested emerald, crested bobwhite, plumbeous seedeater, yellowish pipit and fork-tailed palm swift.
- Further research is needed to understand both immediate and long-term effects of fire on wildlife, with a focus on responses to the spread of fire over time, wildlife mortality documentation and the importance of integrating traditional knowledge into fire management policies.

Introduction

In the Rupununi, fire forms an intricate part of the local ecology and culture. Indigenous communities use fire for a multitude of purposes, from protection of livelihoods to promotion of vegetation growth in shifting cultivation systems (Rodríguez *et al.*, 2011). For example, fire has been used to promote nutrient cycling for farming; to stimulate flowering of plants to induce fruiting; to hunt; to harvest wild honey; and to control plant fuel, thus preventing uncontrolled wildfires and protecting habitat and housing (Bilbao, Leal and Méndez, 2010; Rodríguez *et al.*, 2011; Welch, 2014). Since the introduction of ranching during colonial times, fire has also been used in cattle management,

for example to stimulate new vegetation growth for grazing (Eloy *et al.*, 2019).

According to the traditional hunting calendar of the Wapishana people inhabiting the South Rupununi region, hunting with fire is seasonally limited to a set of target species and their associated habitats (South Central and South Rupununi Districts Toshaos Councils, 2012). In August, forest edges are burned to chase wildlife out for hunts. In September and October, iguanas (*Iguana iguana*) and their eggs are hunted by burning the top of savannah hills. In December, swamps are burned for hunts. During Easter time, fire is used to hunt in both savannahs and swamps. Target species may include white-tailed deer (*Odocoileus cariacou*), red-rumped agouti (*Dasyprocta leporina*), armadillo (*Dasypus* spp.), tortoise (*Chelonoidis denticulata* and *C. carbonarius*) and their eggs (IUCN, 2022). *Chelonoidis denticulata* is listed as vulnerable by the International Union for Conservation of Nature (IUCN).

Hunting with fire for commercial purposes to supply the wildlife trade, such as for tortoises and finches (chiefly *Sporophila angolensis* or towa-towa), has also been reported (Rodríguez *et al.*, 2011). Recently, the increasing loss of traditional practices and associated knowledge, has led to some fires being lit accidentally, for fun, or under poor management. The large communal burns traditionally used to hunt are now managed by small family groups, resulting in the absence of community-level planning and in a smaller number of persons tending to safety, a role originally assumed by the women (Rodríguez *et al.*, 2011). Nevertheless, communities are striving to reinstate safe fire management. This includes respecting traditions such as no burning at spiritual sites or important resource sites (for example, the *Mauritia flexuosa* stands known as ité groves and wildlife breeding areas); establishing targeted fire management areas to help protect habitats (e.g. bush islands); and patch burning to avoid large-scale habitat destruction (South Central and South Rupununi Districts Toshaos Councils, 2012).

©FAO/Marlondag
Fires can be deliberately set to encourage grass regrowth for livestock

©SRCS/Luke McKenna
An aerial view of two locations in Shulinab village showing the before and after effects of fire

Most of the literature on the impacts of fire on wild animals in savannahs has focused mainly on small mammals (Gonzales et al., 2021; Ondei et al., 2021; Shaw *et al*., 2021; Gonzales et al., 2021; Ondei et al., 2021) and birds (Zwarts *et al*., 2023). A very recent review of studies conducted in different savannah types across the globe concluded that small mammals responded negatively to a loss of vegetation cover from fire (Bergstrom *et al*. 2023). However, there is little information on the impacts of fire on medium to large mammals and birds in neotropical savannahs. Two very recent studies have been conducted in the Cerrado in Brazil. Souza *et al.,* (2023) showed that deer species were not significantly affected by the spatial and temporal pattern of pyro activities, whereas tapirs preferred to use fire mosaics with lower diversity of fire frequencies. Maned wolves more intensively used mosaics with high fire age diversity and a high proportion of recently burned areas (Souza *et al.* 2023). Nunes *et al.*, (2023) found that herbivores (tapirs and pampas deer) were common in the burned areas, with an increase in the relative abundance of carnivores the second year after fire.

In this chapter, we show the results of our research on the short impacts of fire on mammal and bird species abundance and diversity in the Rupununi savannahs. In addition, we evaluated changes in bird species composition over time shortly after a fire. We predicted that savannah-adapted species would have a positive or no short-term response to fire, whereas forest-adapted species would show a negative response.

Methods

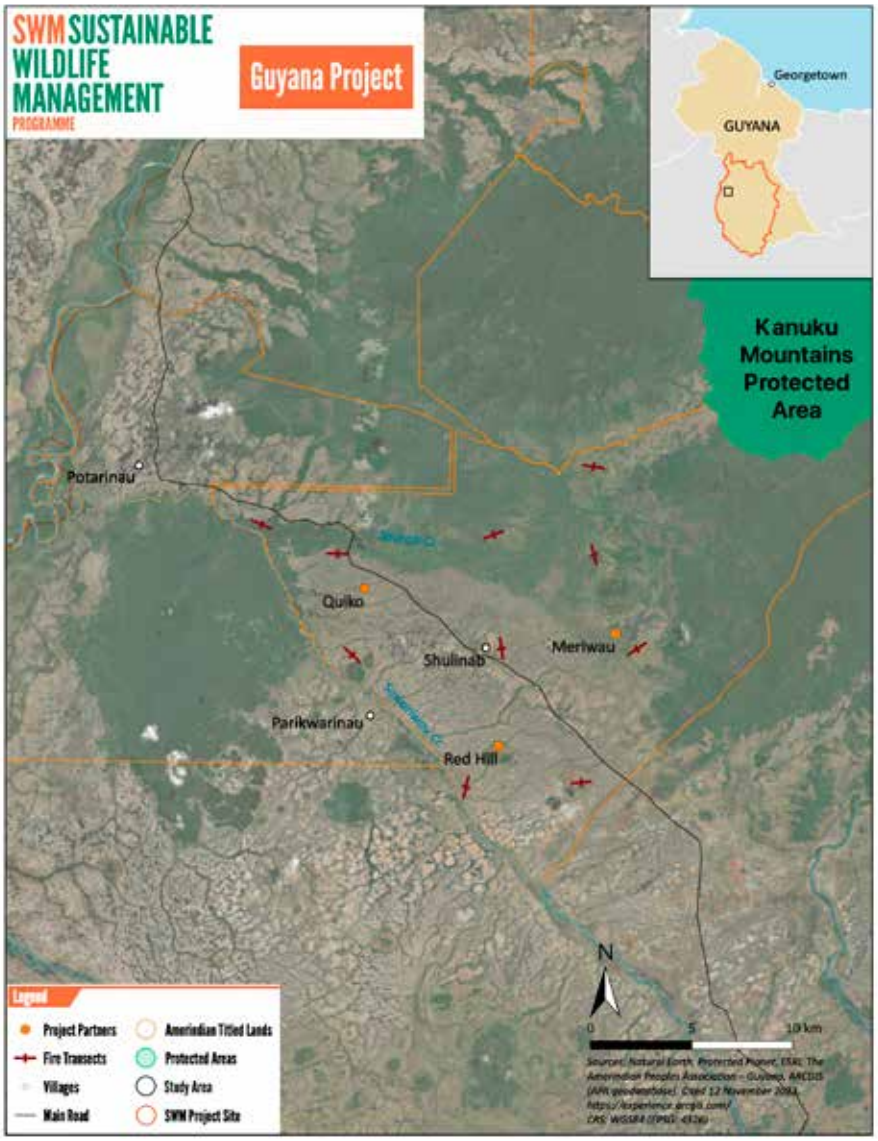
Sampling was conducted in the territory of the Indigenous village of Shulinab.

Mammals

To study the occurrence of mammals in burned areas we used transects. Ten 1-km long transects were selected through consultations with the Shulinab Village Council and the fire committee, and by considering habitat types, distance to main roads, livelihood use and fire management sites (see Table 14).

Transects were traversed on foot by two observers over the course of one hour between 05.30 and 07.30 a.m. every ten to twenty days between March 2021 and February 2022, depending on accessibility – sometimes limited due to flooding. The study did not affect the natural course of events; transects that were unburned in early dry season were not 'controlled' and could eventually burn later in the year. This type of approach can monitor progressive fires that burn different areas of the savannah landscape as the dry season continues. In each visit, the team recorded the season during which the survey took place (either dry or

Figure 17. Map of the study area in South Rupununi, Region 9, Guyana, with the locations of the 1-km sampling transects



The boundaries and names shown and the designations used on this/these map(s) do not imply the expression of any opinion whatsoever on the part of FAO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers and boundaries. Dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Table 14. Description of transects*

Transect	Start	End	Habitat types	Fire and management	Burn**
	LAT/LON	LAT/LON			
SHU-1	3.061528 - 59.70786	3.070556 -59.70933	Tree covered and open savannah, wetland swamp	Some burning for cattle and to protect against bigger fires entering the village	No
SHU-2	3.117667 -59.812	3.121111 -59.82028	Bush island/Imatewau bush, tree covered savannah, swamp/ité bush*, seasonally flooded forest and wetland system	New farming area – burning expected to increase, including in forested area; with some controlled burning in savannah	No
SHU-3	3.059056 -59.77156	3.065111 -59.77819	Bush island – savannah ecotone (mostly a wooded savannah mixed with savannah and forest species), black rock, tree covered and open savannah, through swamp/wetland	Burning for access and cattle management	No
SHU-4	3.008944 -59.72228	2.999639 -59.72433	Semi-open to open savannah, ité along creek, bush island, open savannah	Burning occurs up to the creek	No
SHU-5	3.006833 -59.67631	3.007639 -59.66789	Open savannah, up an isolated mountain with open savannah, savannah-forest ecotone, wetland. Near road	Burning for cattle management. Important bush island on top of an isolated mountain in the savannah	YES
SHU-6	3.064361 -59.65208	3.069556 -59.64464	Creek, swamp, open savannah	Fire management: controlled burning for cattle management	No
SHU-7	3.112722 -59.66947	3.104306 -59.66697	Mountain with open savannah, large wetland/swamp, lowland forest	No burns for more than two years	Yes
SHU-8	3.146972 -59.66478	3.148139 -59.67356	Mountain with open savannah, open savannah (Kanuku Mountain foothills), edge of lake with wetland/swamp	Burns for fishing/hunting access	Yes
SHU-9	3.114889 -59.71708	3.118278 -59.70881	Open savannah in between forest and forested foothills, bush island/forest, tree and open savannah, open savannah	Primary forest replaced by secondary growth due to frequent burning, for hunting and to protect farms. Past grazing area; recent re-use for grazing	Yes
SHU-10	3.106861 -59.77781	3.107028 -59.78672	Main Lethem/South Road, open savannah, bush along creek, farming area, open savannah	2017–2018 large wildfire, which prompted the village's participation in the REDD+ readiness programme and the fire management plan	Yes

**Ité (Mauritia flexuosa); **Designated controlled burn site*

Source: Paemelaere et al. 2023. CIFOR-ICRAF.

**The 'Fire and management' column provides a description of the type of fire that has been occurring on this site, based on information from the fire committee. The 'Burn' column indicates whether the site is included in a controlled burning regime. Exclusion of a site from this fire plan does not necessarily mean no burns are occurring at that site, especially because the management plan has not been fully implemented yet.*

wet), and the number of new fires observed during the visit. As such, for each transect, we calculated the overall 'number of fires' across the period of the research.

In each transect, the mammal surveyors recorded all mammals seen or identifiable through tracks or signs (e.g. faeces, remains, burrows), as well as live sightings. Once recorded, tracks and signs were erased to prevent duplicate records in subsequent surveys. Using the mobile application KoboCollect, the mammal surveyors recorded species, type of sighting (live or through tracks or signs), number of individuals, activity and a GPS location. For each observation, we also calculated the number of 'days since last fire' based on observations made at the level of the transect.

To explore the impact of fire frequency, we ran linear models with species diversity (Shannon Diversity Index), species richness, relative abundance of observations (as number of observations divided by survey effort), and relative abundance of live sightings. The independent variable was 'number of fires'. Mammal species with more than 30 observations were included in a simple regression to look at the relationship between species relative abundance and the frequency of fire on the transects, calculated as 'number of fires'. Relative abundance indices (RAIs) were calculated as the number of observations per kilometre of transect walked.

To evaluate whether 'days since last fire' had an effect on the number of species detected or the number of observations during a survey, we used a Poisson generalized additive mixed model (GAMM) which permits a non-linear relationship between dependent and independent variables, and accounts for a dependence structure. Dependent variables were 'total number of live observations' and 'number of species', while the independent variables were 'days since last fire', 'forest', 'connectivity', 'water', 'road' and 'season'. 'Forest' is a binary variable indicating whether the transect traversed any type of forest. 'Connectivity' is an ordinal variable indicating the quality and size of forests forest for the transects crossing them. 'Forest' and 'connectivity' are associated, and therefore were not used together as independent variables. 'Water' is an ordinal variable indicating the presence of permanent water bodies, and their distance from the transects. 'Road' is a binary variable indicating the presence of major roads within 1 km of the transect. Considering that the impact of time since burning has been shown not to be linear (Briani *et al*., 2004; Green *et al.*, 2015), it was used here as the smoothing variable. 'Transect' was included as the dependence structure to account for repeated surveys on the same transects. All analyses were conducted in Program R (R Core Team, 2020).

©SRCS/Luke McKenna
Maxi Ignace, an SRCS fire team ranger, looks for birds along one of the Shulinab village transects

Birds

For birds, fire chase survey points were established between 14 November 2021 and 5 April 2022, the peak of the Rupununi fire season. A fire chase is an opportunistic survey method in which an observer locates ongoing savannah fires and conducts bird surveys in the burned areas as soon as it is safe to do so. Burn scars selected for fire chase surveys were at least 100 m in diameter. The surveyor selected a point inside the burned patch at least 50 m away from any edge. From this survey point, for ten minutes, the surveyor counted all birds seen and/or heard and noted whether they were within the 50 m radius. Flyovers (birds moving in direct flight over the habitat, but not interacting with it or foraging in the airspace above it) were also noted, but were not included in the analyses. Fire chases were initiated during daylight hours to ensure that observers could conduct bird surveys whenever fires were found. All active fire points were marked with GPS coordinates.

A total of 44 fire chase points were established. All were resurveyed using the same methodology after two weeks, and 22 of them were surveyed a third time one month after the initial survey. Repeat surveys were conducted only in the early morning hours (before 08.45).

We calculated mean and median species richness for surveys conducted at zero, 15 and 30 days post-fire, excluding flyovers and species observed more than 50 m from survey points. To assess preferences of bird species for particular post-fire successional stages, we calculated the proportion of individuals recorded in each stage and noted any sizable differences in detections (generally >10 percent) between stages.

Results and discussion

Mammals

Over 210 km of surveys, 574 individual observations of signs of (435) or live (139) mammals were recorded. We documented 25 species in total, 21 of which were observed live, and 18 were detected through signs (see Table 15). Overall, the total number of observations and species detected was not significantly higher in the wet season compared to the dry season, although fires were less common in the rainy season. We also did not find a significant relationship between "total number of fires' and the number of species detected. Species diversity indices showed a negative but non-significant relationship with fire frequency (Shannon: $F(1,8) = 0.115$, $P = 0.338$; Simpson: $F(1,8) = 0.283$, $P = 0.609$).

Table 15. Summary of mammal observations on the transects

English name	Species	Sign
Agouti	*Dasyprocta leporina*	Live, tracks
Capybara	*Hydrochoerus hydrochaeris*	Live, tracks
Labba	*Cuniculus paca*	Live, tracks, nest/hole
Mouse		Live
Pygmy rice rat	*Oligoryzomys* sp.	Live
Northern Amazon red squirrel	*Sciurus igniventris*	Live
Tamandua	*Tamandua tetradactyla*	Tracks
Giant anteater	*Myrmecophaga tridactyla*	Live, tracks
Nine-banded armadillo	*Dasypus novemcinctus*	Live, nest/hole, tracks
Brazilian tapir	*Tapirus terrestris*	Tracks
Bush deer	*Mazama* sp.	Live, tracks
Collared peccary	*Pecari tajacu*	Live
White-tailed deer	*Odocoileus cariacou*	Live, tracks, scat
Savannah fox	*Cerdocyon thous*	Live, tracks, scat
Bush dog	*Speothos venaticus*	Live, track
Tayra	*Eira Barbara*	Live
Ocelot	*Leopardus pardus*	Live, tracks
Jaguar	*Panthera onca*	Live, tracks
Puma	*Puma concolor*	Tracks
Capuchin monkey	*Cebus* sp.	Live
Howler monkey	*Alouatta macconnelli*	Live
Squirrel monkey	*Siamiri sciureus*	Live
Monkeys	*Species?*	Live
Guianan saki monkey	*Pithecia pithecia*	Live

Source: Paemelaere et al. 2023. CIFOR-ICRAF.

In terms of individual species abundance, forest and savannah species responded differently to fire frequency. Both tapir (*Tapirus terrestris*) and brocket deer (*Mazama* spp.) showed a negative relationship with 'total number of fires' but only for tapir was the trend significant [F(1,8) = 5.896, P = 0.041; see Figure 18]. On the other hand, savannah fox (*Cerdocyon thous*) and nine-banded armadillo (*Dasypus novemcinctus*) showed a positive trend (see Figure 18). Savannah deer (*Odocoileus cariacou*) showed no significant trend.

Throughout the study, the giant anteater, savannah fox and savannah deer were repeatedly detected on the burn scars, both through tracks and live sightings. These species may have adapted to food availability associated with fires. Termites, a primary food source for anteaters and armadillos, build fire-resistant mounds and may even increase in number after a fire event (Prada and Marinho-Filho, 2004). Vegetation regrowth may temporarily attract savannah deer, and carcasses can attract scavengers (Moe, Wegge and Kapela, 1990). Fresh shoots also attract insects (Prada, Marini-Filho and Price, 1995), which in turn may attract insectivores and their predators.

The GAMM showed that total number of species observed was explained by 'connectivity' [F(2) = 9.437, P = 0.0001] and 'road' [F(1) = 9.134, P = 0.0029], showing a non-linear relationship with 'days since last fire' [F92.55510 = 0.0253]. The number of mammal species detected decreased immediately after the fire, then increased until about 100 days after the fire, after which it decreased again [F(2.5551 = 0.0253; see Figure 19]. The model explained 31.5 percent of the variation in the data. Nevertheless, when accounting for seasonality, 'days since last fire' was no longer significant (P = 0.06).

The detectability of tracks and signs differ between species based on their weight, and vary with transect characteristics, such as substrate, vegetation cover and rainfall (Gompper *et al*., 2006). Tracks have been shown to correspond well with species abundance for medium and large mammals (Lyra-Jorge *et al*., 2008). However, there is a discrepancy between the time of detection of the track and

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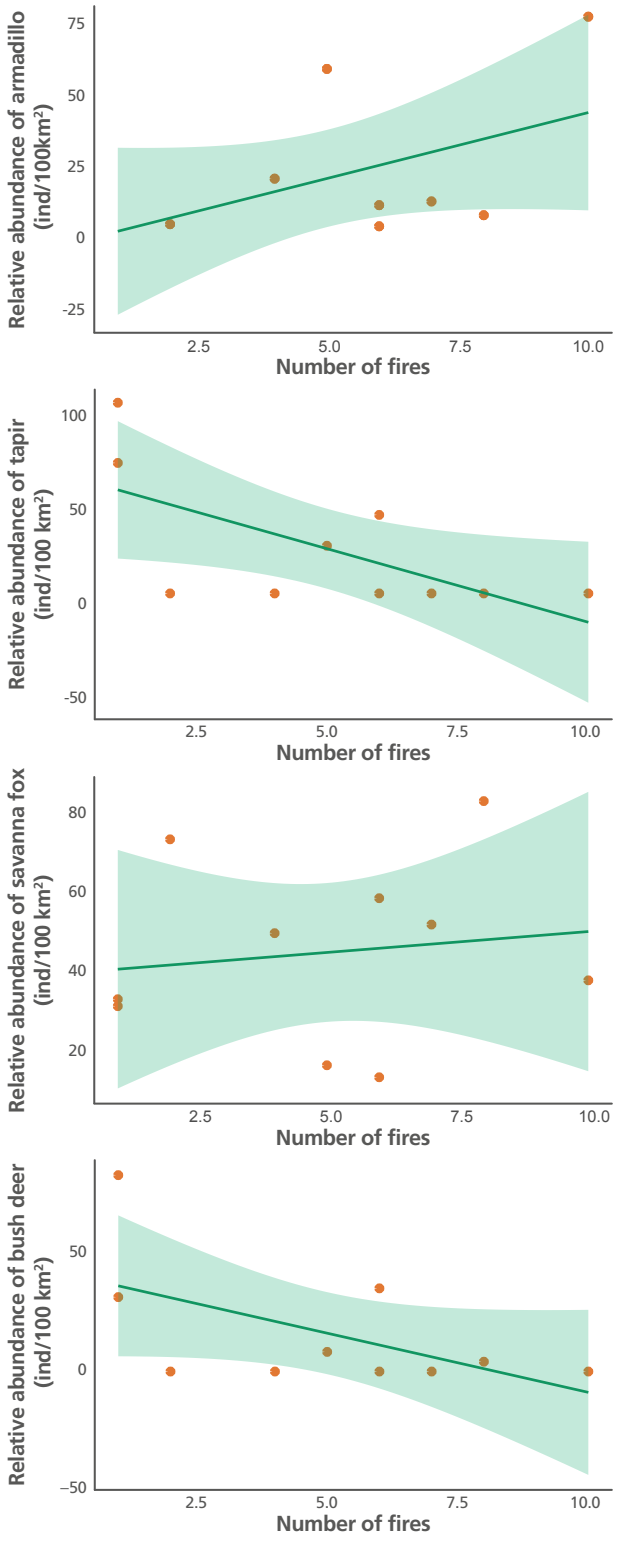
Susan Balvadore, an SRCS fire team ranger, notes signs of mammals such as this tapir track along a transect

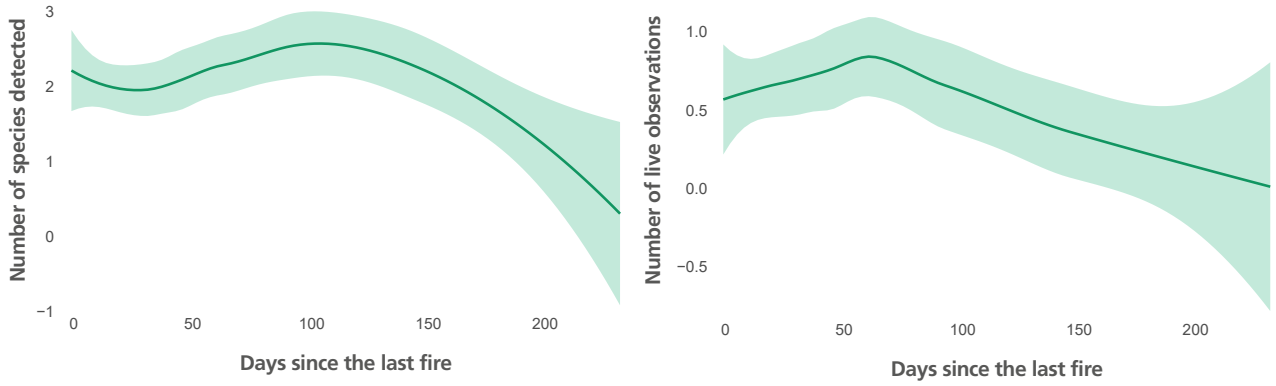
Figure 18. Relationship between species Relative Abundance Index (RAI) on the transects and fire frequency (number of fires)*



Source: Paemelaere et al. 2023. CIFOR-ICRAF.

**For species showing trends that were not statistically significant, we only present the relationship with number of fires, which resulted in the higher R2 (value indicating how much of the data are explained by the model). Left: forest species, Right: savannah species. R2 is given for the species that showed a significant association at alpha = 0.05.*

Figure 19. Total number of mammal species detected (tracks, signs and live; left) and number of live observations (right) in relation to days since the last fire as modelled with the GAMM analysis



Source: Paemelaere et al. 2023. CIFOR-ICRAF.

the time of crossing of the mammal. To limit this mismatch, we visited transects every ten to 20 days, an interval of time shorter than the time for a shift in response to occur. Finally, live sightings indicated a similar pattern to the results based on all observations combined, suggesting a correct interpretation of tracks and signs (see Figure 19).

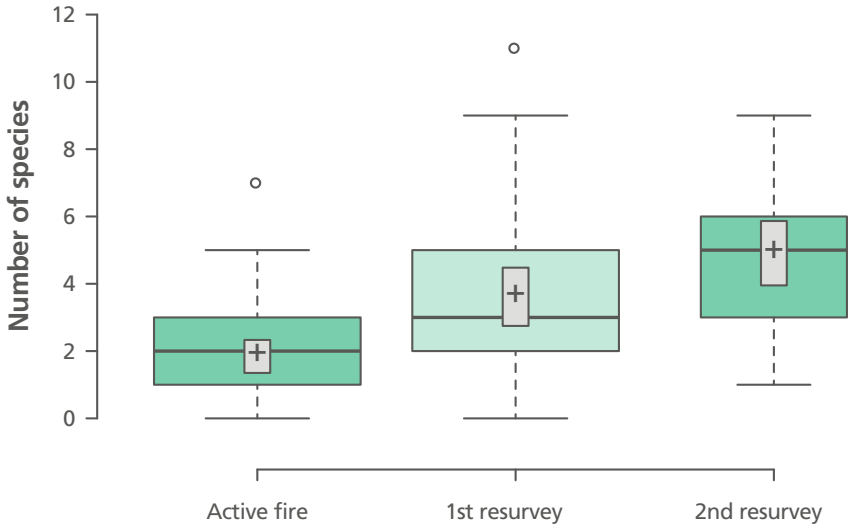
Birds

The fire chase surveys recorded 133 species of birds during 110 survey events at 44 points. Seventy-six species were observed at least once within 50 m of the survey points (see Table 16); the others were noted only outside of a 50 m radius or flying over the survey area. Although these species may have been using habitats impacted by fire, we considered the 76 species listed in Table 16 to be most closely associated with the habitats in the immediate vicinity of the survey points.

Most bird species avoided active burns. Of the 133 species detected overall, only 27 were observed within 50 m of a survey point during an active burn. Species diversity increased substantially two weeks after a burn, and appeared on track to increase further, albeit more modestly, up to one month from the burn event. Mean species diversity within 50 m of survey points was significantly higher in post-fire habitats than in active burns (see Figure 20). Almost all species observed in active burns were detected with greater frequency in subsequent surveys, with a few notable exceptions. Three species of raptors – savannah hawk (*Buteogallus meridionalis*), crested caracara (*Caracara cheriway*) and white-tailed hawk (*Geranoaetus albicaudatus*) – were detected with much greater frequency, and in greater numbers, in active burns than in post-fire habitats (see Table 16). Another raptor, the Aplomado falcon (*Falco femoralis*), was only observed near active burns. Eleven additional species showed a notable preference for post-fire habitats; seven of these species were not observed at all in the vicinity of active burns (see Table 16).

The fire chase results confirmed that while fire had a short-term suppressive effect on diversity and abundance of most bird species, substantial recovery occurred as little as two weeks after a fire. The raptor species that were detected more frequently at active fires, and particularly the savannah hawk, are widely known to hunt in the vicinity of fires to take advantage of prey flushed out, disoriented or killed by the flames.

Figure 20. Median (solid black lines) and mean (+ signs) species richness for survey points during active fires and at 15 and 30 days post-fire*



Source: Paemelaere et al. 2023. CIFOR-ICRAF.

**Data are for observations inside a 50-m radius around the survey points; inclusion of observations outside of 50 m increased species richness but showed the same pattern. Gray boxes around means are 95% confidence intervals.*

Table 16. List of 76 species most closely associated with active fires and post-fire habitats around the fire chase survey points

Species	English name	Total Obs	Active	RES 1	RES 2
Buteogallus meridionalis	Savannah hawk*	47	0.91	0.09	0.14
Caracara cheriway	Crested caracara*	46	0.84	0.14	0.14
Tyrannus savana	Fork-tailed fly-catcher	45	0.48	0.34	0.41
Mimus gilvus	Tropical mock-ingbird	41	0.27	0.43	0.45
Pitangus sulphuratus	Great kiskadee	34	0.20	0.36	0.41
Campylorhynchus griseus	Bicolored wren	29	0.18	0.30	0.36
Tyrannus melancholicus	Tropical kingbird	28	0.18	0.32	0.27
Ammodramus humeralis	Grassland spar-row***	25	0.02	0.30	0.50
Sturnella magna	Eastern mead-owlark	24	0.00	0.34	0.41
Geranoaetus albicaudatus	White-tailed hawk*	21	0.45	0.02	0.00
Theristicus caudatus	Buff-necked Ibis	21	0.18	0.16	0.27
Myiarchus tyrannulus	Brown-crested flycatcher	20	0.11	0.23	0.23
Pyrocephalus rubinus	Vermilion fly-catcher	20	0.16	0.18	0.23
Columbina minuta	Plain-breasted Ground Dove	19	0.11	0.23	0.18
Progne chalybea	Grey-breasted Martin***	17	0.05	0.14	0.41
Sporophila plumbea	Plumbeous seed-eater**	14	0.00	0.25	0.14
Thraupis palmarum	Palm tanager	14	0.14	0.14	0.09
Elaenia flavogaster	Yellow-bellied elaenia	13	0.05	0.16	0.18
Euphonia finschi	Finsch's euphonia	13	0.07	0.16	0.14
Turdus leucomelas	Pale-breasted thrush***	13	0.00	0.14	0.32
Anthus lutescens	Yellowish pipit**	12	0.05	0.20	0.05
Cathartes aura	Turkey vulture	12	0.09	0.11	0.14
Crotophaga ani	Smooth-billed ani	12	0.09	0.07	0.23
Elaenia chiriquensis	Lesser elaenia	12	0.05	0.18	0.09
Falco sparverius	American kestrel	12	0.09	0.16	0.05
Icterus nigrogularis	Yellow oriole	12	0.02	0.18	0.14
Hirundo rustica	Barn swallow	11	0.14	0.09	0.05
Tachornis squamata	Fork-tailed palm swift**	10	0.00	0.18	0.09
Zenaida auriculata	Eared dove	10	0.05	0.11	0.14
Chrysuronia brevirostris	White-chested emerald**	9	0.02	0.16	0.05
Elaenia cristata	Plain-crested elaenia	9	0.00	0.14	0.14
Megarynchus pitangua	Boat-billed flycatcher	9	0.02	0.16	0.05

Species	English name	Total Obs	Active	RES 1	RES 2
Milvago chimachima	Yellow-headed caracara	9	0.05	0.11	0.09
Sakesphorus canadensis	Black-crested antshrike	9	0.00	0.14	0.14
Leistes militaris	Red-breasted meadowlark	8	0.02	0.07	0.18
Piranga flava	Hepatic tanager	8	0.07	0.09	0.05
Glaucidium brasilianum	Ferruginous pygmy owl***	7	0.00	0.02	0.27
Amazona ochrocephala	Yellow-crowned parrot	6	0.02	0.07	0.09
Campephilus melanoleucos	Crimson-crested woodpecker	6	0.05	0.07	0.05
Falco femoralis	Aplomado falcon*	6	0.14	0.00	0.00
Leptotila verreauxi	White-tipped dove	6	0.00	0.07	0.14
Polioptila plumbea	Tropical gnat-catcher	6	0.00	0.11	0.05
Patagioenas cayennensis	Pale-vented pigeon	5	0.02	0.05	0.09
Troglodytes aedon	House wren***	5	0.00	0.02	0.18
Amazona amazonica	Orange-winged parrot	4	0.00	0.05	0.09
Capsiempis flaveola	Yellow tyrannulet	4	0.02	0.02	0.09
Chaetura brachyura	Short-tailed swift	4	0.00	0.07	0.05
Formicivora grisea	White-fringed antwren	4	0.00	0.05	0.09
Myiarchus swainsonii	Swainson's fly-catcher	4	0.00	0.05	0.09
Sporophila nigricollis	Yellow-bellied seedeater	4	0.00	0.05	0.09
Vanellus chilensis	Southern lapwing	4	0.00	0.05	0.09
Colinus cristatus	Crested bob-white**	3	0.00	0.07	0.00
Columbina talpacoti	Ruddy ground dove	3	0.02	0.02	0.05
Elaenia parvirostris	Small-billed elaenia	3	0.02	0.02	0.05
Fluvicola pica	Pied water tyrant	3	0.02	0.05	0.00
Phaeomyias murina	Mouse-coloured tyrannulet	3	0.00	0.00	0.14
Tachycineta albiventer	White-winged swallow	3	0.02	0.02	0.05
Tyrannopsis sulphurea	Sulphury fly-catcher	3	0.00	0.05	0.05
Arundinicola leucocephala	White-headed marsh tyrant	2	0.02	0.02	0.00
Certhiaxis cinnamomeus	Yellow-chinned spinetail	2	0.02	0.00	0.05
Donacobius atricapilla	Black-capped donacobius	2	0.00	0.02	0.05
Gampsonyx swainsonii	Pearl kite	2	0.02	0.02	0.00
Jacana jacana	Wattled jacana	2	0.00	0.02	0.05
Sporophila angolensis	Chestnut-bellied seed finch	2	0.00	0.02	0.05
Sporophila lineola	Lined seedeater	2	0.00	0.02	0.05
Volatinia jacarina	Blue-black grassquit	2	0.00	0.02	0.05
Eupsittula pertinax	Brown-throated parakeet	1	0.00	0.02	0.00
Chloroceryle americana	Green kingfisher	1	0.00	0.02	0.00
Chlorostilbon mellisugus	Blue-tailed emerald	1	0.00	0.02	0.00
Chordeiles pusillus	Least nighthawk	1	0.00	0.02	0.00
Geothlypis aequinoctialis	Masked yellowthroat	1	0.00	0.00	0.05
Legatus leucophaius	Piratic flycatcher	1	0.00	0.02	0.00
Phaethornis augusti	Sooty-capped hermit	1	0.00	0.02	0.00
Polytmus guainumbi	White-tailed goldenthroat	1	0.02	0.00	0.00
Progne tapera	Brown-chested Martin	1	0.00	0.02	0.00
Stilpnia cayana	Burnished-buff tanager	1	0.00	0.02	0.00

Source: Paemelaere et al. 2023. CIFOR-ICRAF.

**Species are listed in decreasing order of overall detection frequency. The columns "Active", "RES 1" and "RES 2" indicate the frequency of occurrence of each species for each of the survey rounds. Species marked with a single asterisk (*) were strongly associated with active fires. Species associated with short-term (RES 1) and longer-term (RES 2) post-fire habitats are marked with two and three asterisks, respectively.*

©FAO/Marlondag
A ferruginous pygmy owl looks down at the ranger team

Conclusion and recommendations

We investigated medium to large mammal and bird short-term responses to fire in a savannah-forest matrix in southwestern Guyana where Indigenous Peoples practise traditional fire management and where fire is used for ranching.

We found that medium to large mammal species' diversity was not affected significantly by the frequency of fire over a one-year period. Nine-banded armadillos and savannah foxes showed a positive relationship with fire frequency and were commonly detected on burn scars. Conversely, tapir was significantly less abundant in more frequently burnt areas. The number of mammal live sightings decreased shortly after a fire, but then increased to a peak, 50 days after the fire, before decreasing again.

Concerning birds, we found that most bird species avoided active burns. However, three species of raptors – savannah hawk (*Buteogallus meridionalis*), crested caracara (*Caracara cheriway*) and white-tailed hawk (*Geranoaetus albicaudatus*) – were detected with much greater frequency, and in greater numbers, in active burns than in post-fire habitats. Species diversity increased substantially two weeks after a burn. Five species showed a notable preference for habitats that had been recently burnt, including the white-chested emerald, crested bobwhite, plumbeous seedeater, yellowish pipit and the fork-tailed palm swift.

Our results show that fire in open habitat seem to provide benefits to species inhabiting these areas, whereas fire spreading into forest – bush islands, gallery forest and forest edges – may have negative impacts on forest dependent mammals and birds, as suggested elsewhere (Trolle, 2003). Therefore, it is crucial to regulate fire through regular burning and to prevent the spread of fire into the forest, as done in traditional practices. Integrating both traditional knowledge and scientific research into national fire management policies is recommended, as it can ensure that species adapted to long standing fire management practices continue to benefit, while also minimizing the negative effects on other species.

Further research is needed to understand the long-term effects of fire on wildlife populations, particularly for species inhabiting the forest-savannah ecotone. Even when short-term responses are not present or are limited, long-term negative impacts can arise through microhabitat changes (Banks *et al.*, 2011). This will be particularly important if fire scenarios change due to events beyond the control of fire managers, such as extreme droughts and landscape-level habitat changes (Kelly *et al.*, 2020).

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A savannah hawk looks for prey from the top of a tree

References

Banks, S.C., Knight, E.J., McBurney, L., Blair, D. & Lindenmayer, D.B. 2011. The effects of wildfire on mortality and resources for an arboreal marsupial: Resilience to fire events but susceptibility to fire regime change. *PLoS ONE*, 6(8): https://doi.org/10.1371/journal.pone.0022952

Bergstrom, B.J., Scruggs, S.B. & Vieira, E.M. 2023. Tropical savanna small mammals respond to loss of cover following disturbance: A global review of field studies. *Frontiers in Ecology and Evolution*, 11: 1017361.

Bilbao, B.A., Leal, A.V. & Méndez, C.L. 2010. Indigenous Use of Fire and Forest Loss in Canaima National Park, Venezuela. Assessment of and Tools for Alternative Strategies of Fire Management in Pemón Indigenous Lands. *Human Ecology*, 38(5): 663–673. https://doi.org/10.1007/s10745-010-9344-0

Briani, D.C., Palma, A.R.T., Vieira, E.M. & Henriques, R.P.B. 2004. Post-fire succession of small mammals in the Cerrado of central Brazil. *Biodiversity and Conservation*, 13(October 2004): 1023–1037. https://doi.org/10.1023/B

Eloy, L., Schmidt, I.B., Borges, S.L., Ferreira, M.C. & dos Santos, T.A. 2019. Seasonal fire management by traditional cattle ranchers prevents the spread of wildfire in the Brazilian Cerrado. *Ambio*, 48(8): 890–899. https://doi.org/10.1007/s13280-018-1118-8

Gompper, M.E., Kays, R.W., Ray, J.C., Lapoint, S.D., Bogan, D.A. & Cryan, J.R. 2006. A Comparison of Noninvasive Techniques to Survey Carnivore Communities in Northeastern North America. *Wildlife Society Bulletin*, 34(4): 1142–1151. https://doi.org/10.2193/0091-7648(2006)34[1142:acontt]2.0.co;2

González, T.M., González-Trujillo, J.D., Munoz, A. & Armenteras, D. 2021. Differential effects of fire on the occupancy of small mammals in neotropical savanna-gallery forests. *Perspectives in Ecology and Conservation*, 19(2): 179–188.

Green, D.S., Roloff, G.J., Heath, B.R. & Holekamp, K.E. 2015. Temporal dynamics of the responses by African mammals to prescribed fire. *Journal of Wildlife Management*, 79(2): 235–242. https://doi.org/10.1002/jwmg.827

Hale, S., Mendoza, L., Yeatman, T., Cooke, R., Doherty, T., Nimmo, D. & White, J.G. 2022. Evidence that post-fire recovery of small mammals occurs primarily via in situ survival. *Diversity and Distributions*, 28(3): 404–416.

Henriques, R.P.B., Briani, D.C., Palma, A.R.T. & Vieira, E.M. 2006. A simple graphical model of small mammal succession after fire in the Brazilian Cerrado. *Mammalia*, 70(3–4): 226–230. https://doi.org/10.1515/MAMM.2006.044

IUCN 2022. *The IUCN Red List of Threatened Species. Version 2022-2*. https://www.iucnredlist.org. Accessed on 10 February 2023.

Kelly, L.T., Giljohann, K.M., Duane, A., Aquilué, N., Archibald, S., Batllori, E., Bennett, A.F., Buckland, S.T., Canelles, Q., Clarke, M.F. *et al*. 2020. Fire and biodiversity in the Anthropocene. *Science*, 370(6519): https://doi.org/10.1126/science.abb0355

Legge, S., Smith, J.G., James, A., Tuft, K.D., Webb, T. & Woinarski, J.C. 2019. Interactions among threats affect conservation management outcomes: Livestock grazing removes the benefits of fire management for small mammals in Australian tropical savannas. *Conservation Science and Practice*, 1(7): e52.

Lyra-Jorge, M.C., Ciocheti, G., Pivello, V.R. & Meirelles, S.T. 2008. Comparing methods for sampling large- and medium-sized mammals: Camera traps and track plots. *European Journal of Wildlife Research*, 54(4): 739–744. https://doi.org/10.1007/s10344-008-0205-8

Moe, S.R., Wegge, P. & Kapela, E.B. 1990. The influence of man-made fires on large wild herbivores in Lake Burungi area in northern Tanzania. *African Journal of Ecology*, 28(1): 35–43. https://doi.org/10.1111/j.1365-2028.1990.tb01134.x

Nunes, B.A., Cunha, A. & Vieira, E.M. 2023. Effects of a large wildfire on the community composition of medium and large mammals in a neotropical savannah. *International Journal of Wildland Fire.*

Ondei, S., Prior, L.D., McGregor, H.W., Reid, A.M., Johnson, C.N., Vigilante, T. *et al.* 2020. Small mammal diversity is higher in frequently compared with frequently burnt rainforest–savanna mosaics in the north Kimberley, Australia. *Wildlife Research*, 48(3): 218–229.

Prada, M., Marini-Filho, O.J. & Price, P.W. 1995. Insects in Flower Heads of *Aspilia foliacea* (Asteraceae) after a Fire in a Central Brazilian Savanna: Evidence for the Plant Vigor Hypothesis. *Biotropica*, 27(4): 513. https://doi.org/10.2307/2388965

Prada, M. & Marinho-Filho, J. 2004. Effects of fire on the abundance of Xenarthrans in Mato Grosso, Brazil. *Austral ecology*, 29(5): 568–573.

R Core Team. 2020. R: A language and environment for statistical computing. Vienna, Austria, R Foundation for Statistical Computing.

Rodríguez, I., Albert, P., La Rose, C. & Sharpe, C.J. 2011. *A Study of the use of fire by Amerindian communities in the South Rupununi, Guyana, with recommendations for sustainable land management. Guyana*. http://wapichanao.communitylands.org/1505780518117-rupununi-fire-study-web.pdf

Shaw, R.E., James, A.I., Tuft, K., Legge, S., Cary, G.J., Peakall, R. & Banks, S.C. 2021. Unburnt habitat patches are critical for survival and in situ population recovery in a small mammal after fire. *Journal of Applied Ecology*, 58(6): 1325–1335.

South Central and South Rupununi Districts Toshaos Councils. 2012. *Thinking together for those coming behind us: An outline plan for the care of Wapichan territory in Guyana*. Gomes, P. & Wilson, H. eds. Region 9, Guyana. 108 pp. Also available at: https://www.lifemosaic.net/images/uploads/Territories_of_Life/TOL_Resources/Plan_de_Vida/Thinking_Together_For_Those_Coming_Behind_Us.pdf

Souza, C.V., Lourenço, Á. & Vieira, E.M. 2023. Species-Specific Responses of Medium and Large Mammals to Fire Regime Attributes in a Fire-Prone Neotropical Savanna. *Fire*, 6(3): 110.

Trolle, M. 2003. Mammal survey in the southeastern Pantanal, Brazil. *Biodiversity and Conservation*, 12(4): 823–836. https://doi.org/10.1023/A:1022489426920

Welch, J.R. 2014. Xavante Ritual Hunting: Anthropogenic Fire, Reciprocity, and Collective Landscape Management in the Brazilian Cerrado. *Human Ecology*, 42(1): 47–59. https://doi.org/10.1007/s10745-013-9637-1

Zwarts, L., Bijlsma, R.G. & van der Kamp, J. 2023. Birds and bush fires in African savannahs. *Ardea*, 111(1): 305–314.

The red siskin community-based conservation and management zone

By Leroy Ignacio, South Rupununi Conservation Society

In 2000, the red siskin (*Spinus cucullatus*) was scientifically "discovered" in Guyana's South Rupununi by a team of scientists from the Smithsonian Institute and local tour guides working with tour operator Rupununi Trails. Previously, the species was only known to exist in a relatively small range in the foothills of the coastal *cordilleras* and eastern Andes of Venezuela and Colombia. Following the official discovery of the red siskin, the tour guides involved in the find established a grassroots conservation society called the South Rupununi Conservation Society (SRCS). Despite being a protected species in Guyana, the red siskin continues to be threatened by the illegal pet trade in the Rupununi.

In 2003, the SRCS initiated a red siskin monitoring programme in Katoonarib, involving community members as red siskin rangers. In 2019, with support from the Sustainable Wildlife Management (SWM) Programme, the SRCS expanded the monitoring programme to five other communities where the red siskin was known to exist. The organization engaged with the Toshaos (elected village leaders) and village councils of these communities to involve community members in the monitoring programme. Rangers from these communities were trained and hired to participate in red siskin monitoring and promote the red siskin as a tourism attraction.

In 2019, population estimates indicated that at least 180 to 360 red siskins persisted in Guyana, leading Birdlife International to classify the South Central Rupununi as the first Important Bird Area (IBA) in Guyana. In 2022, through a consultative process that followed Free, Prior and Informed Consent (FPIC), five communities (Sawariwau, Katoonarib, Shulinab, Sand Creek and Rupunau) agreed to the creation of a Red Siskin Community-Based Conservation Management Zone. The boundary of this zone encompasses the titled lands of these communities and their proposed extensions, covering an area of 130 000 hectares and providing roughly 80 percent protection for the known red siskin range in Guyana.

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A male red siskin is seen on a ciambe tree

©SRCS/Chung Lui
SRCS ranger, Samuel Cyril, inspects a red siskin

3.2. Rupununi roads: connectivity for people and wildlife

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Highlights

- The imminent upgrade of the road network in Guyana calls for careful planning to limit negative impacts on wildlife and avoid costs of post-construction interventions.
- The level of impact on wildlife depends on both the road characteristics, such as location, width and traffic volume, and on the biology of the species.
- We combined a theoretical model with field data to identify priority sites for mitigation actions where wildlife is most likely to approach the road and the risk of interrupted connectivity is highest.
- At the time of the study, roadkill was not a significant concern for any species, but the roadkill pattern could change with shifts in traffic volume or road characteristics. Five roadkill hotspots were identified along the Georgetown-Lethem road and nine along the Lethem-Aishalton road. Roadkill hotspots were associated with high connectivity areas identified through the landscape analysis.
- The crossing-structures evaluation revealed that several bridges and culverts require adjustments to better serve as underpasses for wildlife, now and in the future. Adjustments include: increasing length and height to improve water flow and create dry areas that can be used by wildlife for crossing, preserving natural vegetation around and inside the structures, considering canopy bridges, and managing human activity near the crossing sites.
- This study demonstrates the usefulness of theoretical approaches in mitigating road impact on wildlife and planning wildlife friendly roads, emphasizing the potential of existing bridges and culverts in the Rupununi region to facilitate wildlife crossing and maintain road-friendliness.
- Alterations in habitat and road conditions will impact roadkill rates. We suggest the use of models presented here in future development projects to take a proactive approach in ensuring co-existence between people and wildlife in the Rupununi.

Introduction

Roads are a major driver of habitat degradation, fragmentation and loss of connectivity between wildlife populations (Laurance *et al.*, 2002), leading to genetic isolation and local extinction of species (Jackson and Fahrig, 2011). In remote and rural areas, road networks play a key role in driving socioeconomic development, and their expansion continues to progress rapidly, facilitating access to valuable resources such as timber, gold and oil. However, this growth can have adverse effects on biodiversity and ecosystem services, which are equally crucial for sustaining healthy livelihoods. In the Rupununi, current plans for upgrading the road network call for careful design to limit negative impacts on wildlife and avoid costs of post-construction interventions.

The level of impact on wildlife depends on the road's location, its engineering characteristics – such as width and surface – and on traffic speed and volume (Clevenger, Chruszcz and Gunson, 2003). For example, traffic volume may be more important than road width in determining road avoidance behaviour, although it varies between species depending on their habitat preferences (Jacobson *et al.*, 2016). The species' biology is also a crucial factor determining the extent of impact of a road. Species that are strictly arboreal, those that are adapted to dense forests, and those typically avoiding human activity, are mostly impacted by road construction (Laurance *et al.*, 2008). Within the same species, individuals of different age and gender may also respond differently to roads; for instance, male jaguars tolerate roads better than females (Ovando, 2008).

Jacobson *et al*. (2016) developed a behavioural framework to understand the impact of roads on wildlife beyond roadkill alone. They categorized species based on their natural response to danger as 'non-responders', 'pausers', 'speeders', 'avoiders' and 'opportunists'. Non-responders are unable to identify moving vehicles as threats and try to cross a road independently of traffic, whereas pausers stop or slow down, and speeders run. Avoiders do not approach the road at all. Finally, opportunists are attracted to the road and feed on roadkill. Because non-responders and pausers are not deterred by roads, they are likely victims of roadkill, even at low traffic volumes. When traffic volume becomes very high, pausers do not cross the road and, like avoiders, are impacted by the barrier effect. On the other hand, speeders become victims of traffic collisions with increasing traffic.

To help mitigate road impacts on wildlife, connectivity achieved through underpasses and overpasses for wildlife is crucial. In some cases, bridges and culverts required in road construction can serve as wildlife underpasses (passage under the road) without any additional intervention and, therefore, cost. Overpasses (providing wildlife crossings above traffic), on the other hand, have to be built separately and always involve an additional cost, which can run into the millions of US dollars and are often not cost-effective (Sijtsma *et al*., 2020). Kintsch, Jacobson and Cramer (2015) developed a crossing guild framework that describes species depending on the typology of crossings they use. Generalists (small, medium and large) are willing to cross any structure, provided the size is large enough for them to pass comfortably. Obligates require cover from vegetation or other materials, openness for a clear field of vision throughout the structure, or the presence of water. Finally, specialists need touching canopies or a simulation thereof, tall structures to permit flight, or highly specific conditions that are species-specific.

To limit the impact of roads on wildlife, these complementary behavioural frameworks should be combined with a spatial analysis to identify priority locations for wildlife connectivity. Integrating wildlife friendly designs at the planning phase significantly helps to limit costly *post-hoc* measures to reduce impact. In this chapter, we present the impact evaluation of two major roads in the Rupununi region of Guyana as an example of this approach and include recommendations specific for the region.

Methods

Study site

The study focused on the entire Rupununi region. Data were collected along two major roads: the Georgetown-Lethem Road (GTLR) between the village of Surama and the town of Lethem in the North Rupununi and the road from Lethem to the Indigenous village of Aishalton (LAR) in the South Rupununi. Both are unpaved; GTLR is mostly a laterite gravel road, and LAR is a mainly laterite gravel surface, with some stretches of sand. The roads measure 134 km and 160 km, respectively. GTLR is important for international logistics, with plans for upgrades, while LAR connects villages and ranches as well as the mining area of Marudi. Although there are two major roads leading to Aishalton, with multiple side roads and shortcuts used during the dry season, we focused on the main alignment, the only road under maintenance (see Figure 21).

Species selection

In a desktop analysis, we used existing research to compile a list of vertebrates occurring in the region. We considered terrestrial, arboreal and semi-aquatic species, as well as representative bird species. Species were initially prioritized based on their International Union for Conservation of Nature (IUCN) conservation status, their Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) category, and their importance in food security, trade, tourism and cultural practices for local stakeholders (Conservation International, 2002; Fredericks, Buckley and Persaud, 2016; Pierre and Paemelaere, 2018). From this list, we selected species to ensure representation of the main behavioural responses by Jacobson *et al.* (2016) and crossing guilds by Kintsch, Jacobson and Cramer (2015). A total of 17 species were selected (see Table 17).

Landscape analysis

To identify priority sites for wildlife connectivity across the two roads for the selected species, we conducted a connectivity analysis for Region 9 using the software Circuitscape 4.0 (Shah and McRae, 2008). Circuitscape uses circuit theory to predict the connectivity of a heterogeneous landscape in order to inform conservation decisions. Landscape fragments with low resistance are permeable to movement, while those with high resistance limit dispersal and may create barriers. Layers used for the analysis include land cover, water bodies, mining concessions, farms, towns, tree-cover loss and roads. With these layers, we created a list of attributes important for species movements: land use, distance to forest, distance to forest loss which occurred within the last seven years, distance to water bodies and slope. Attributes were categorized, and a value representing resistance to dispersal was assigned to every category for each of the 17 species using a value between one and 99, with one indicating easy passage and 99 near-impossible passage for the species. Additionally, attributes were given a weight to indicate their importance for the movement of the species. For example, semi-aquatic species had a higher weight assigned to 'distance to water' than others. All species were modelled separately, from which a combined connectivity map was produced.

Roadkill assessment and traffic estimates

Roadkill surveys were conducted on the GTLR and LAR during the dry season between 8 March and 6 May 2019. Two teams of two persons travelled by motorbike or ATV at a speed of 30–40 km/hour and recorded roadkills as well as sightings of wildlife crossing. The roads were travelled, starting at 14.00 one way and at 04.00 on the way back in order to cover both dusk and dawn periods. On each road, we conducted two surveys, one each way, with a four-day break in between. For every roadkill, we recorded date, time, GPS location, distance from roadside, roadside vegetation and presence of fencing. For live sightings, we recorded the type of activity as well. When applicable, we noted the number of individuals, sex and age category (juvenile/adult).

Crossing structure evaluation

We assessed the adequacy of bridges and culverts as wildlife underpasses. Along the GTLR, we evaluated 46 structures, including all 19 bridges and key culverts. Along the LAR, we evaluated 22 bridges and an additional 64 culverts. The evaluation was based on crossing guilds. Of each structure, we recorded structural dimensions, vegetation characteristics in and around the structure, water flow and nearby land use.

Camera trapping at underpasses

To assess which species use bridges and culverts as underpasses, we set 26 camera traps at four bridges along the GTLR, and at four bridges and two culverts along the LAR, between 7 and 10 January 2021. Cameras were collected on 8 April 2021. The number of bridges selected and the duration of the surveys were affected by water levels, which were unexpectedly high for the time of the year. Cameras covered both entrances as well as near-

Table 17. Classification of the selected species according to their habitat requirements and crossing guild*

				Habitat requirements								Crossing guilds			
Species	Common name	IUCN	CITES	Generalist (S)	Generalist (M)	Generalist (L)	Specialist, arboreal	Specialist: (semi) aquatic	Specialist: Aerial	Obligate: Cover	Obligate: Openness	Non-responder	Pauser	Speeder	Avoider
Reptiles															
Eunectes murinus	Green anaconda	LC	II					x				x			
Chelonoidis denticulata	Yellow-footed tortoise	VU	II	x									x		
Melanosuchus niger	Black caiman	CD	I/II					x						x	
Birds															
Crax alector	Black curassow/powis	VU			x									x	
Sporophila angolensis	Chestnut-bellied seed finch	LC							x						x
Mammals															
Ateles paniscus	Red-faced black spider monkey	VU	II				x								x
Cuniculus paca	Lowland paca	LC	III	x										x	
Dasypus sp.**	Nine-banded and greater long-nosed armadillo	LC								x			x		
Hydrochoerus hydrochaeris	Capybara	LC						x						x	
Mazama sp.**	Brocket deer/bush dear					x								x	
Myrmecophaga tridactyla	Giant anteater	VU	II			x						x			
Odocoileus cariacou	White-tailed deer (subsp.)	LC	III								x			x	
Panthera onca	Jaguar	NT	I			x									x
Priodontes maximus	Giant armadillo	VU	I			x									x
Pteronura brasiliensis	Giant otter	EN	I					x					x		
Tapirus terrestris	Brazilian tapir, lowland tapir	VU	II			x								x	
Tayassu pecari	White-lipped peccary	VU	II			x								x	

Source: Paemelaere. 2021. Colombia.

**Based on Jacobson et al. (2016) and Kintsch et al. (2015). S: small, M: medium, L: large. IUCN categories of global threat level: NE: not evaluated, LC: Least Concern, VU: Vulnerable, CD: Conservation Dependent.*
*** In this region, there are two species of Mazama and two species of Dasypus which cannot be easily distinguished in camera trap photographs. All analyses including these data considered the species at the genus level.*

by areas where possible, with two to four cameras per structure. An animal was marked as 'direct observation of crossing ability' if the photograph showed the animal to be under the bridge or inside the culvert.

Field data analysis

To evaluate roadkill rates and to compare between GTLR and LAR, we divided the number of individuals encountered per road by effort, both in terms of distance covered and number of days surveyed. To determine hotspots of roadkill, we applied the 2D Hotspot Analysis in Siriema (Coelho *et al.*, 2014). This analysis identifies hotspots of roadkill based on Monte Carlo simulations, providing a geographical confidence interval. For this purpose, the road was divided into 250-m segments. In each segment, a circle with an initial radius of 250 m was traced, and all roadkill events within the circle were summed up. Subsequently, the radius of the circle was progressively incremented by 250 m with a 90 percent confidence interval. The radius, typically associated with movement patterns of species, was chosen somewhat arbitrarily because we did not record sufficient roadkill to distinguish between species or even classes of animals. To determine the significance of roadkill, the existence of potential barrier effects, and the projections of changing patterns in impacts on wildlife, roadkill data was interpreted within the framework of crossing guilds.

For camera trap data, we calculated the Relative Abundance Index (RAI) per species and per site as the number of independent (>30 minutes apart) photographs of the species multiplied by 100. Rarefaction curves, which show the accumulated species richness with increasing sampling effort, were created in R (R Core Team, 2020) for each monitored structure to evaluate sufficiency of sampling. When the asymptote is reached, sampling effort can be considered sufficient.

Results and discussion

Landscape analysis

The location of highest probability of approaching the road differed per species. The accumulated landscape model identified several key areas along both roads with high probability of wildlife crossing (see Figure 21). Along the GTLR in the North Rupununi, the area between the Santa Fe Farm and the Yakarinta bridges scored high. In partic-

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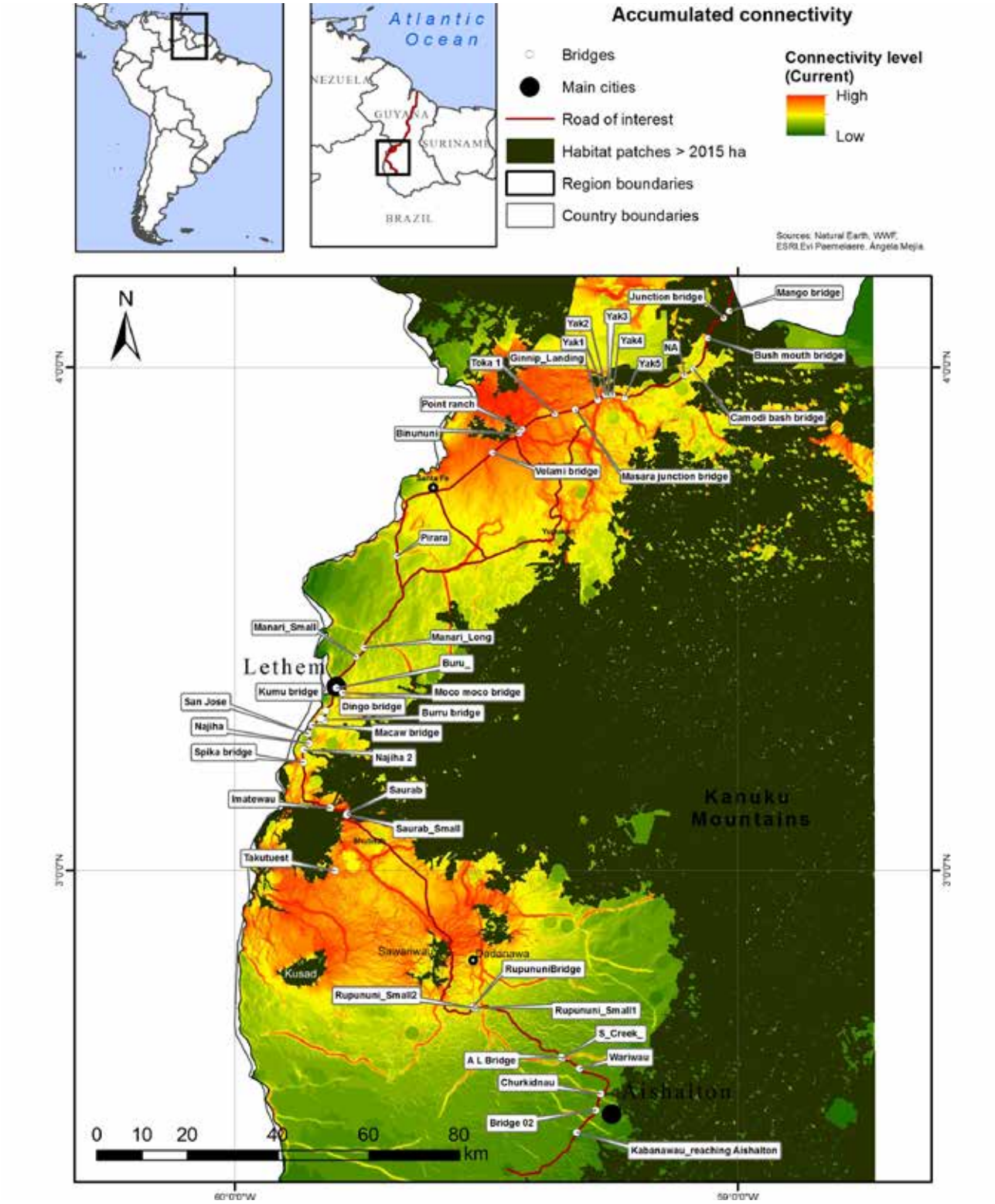
Saurab crossing is one of many bridges along the Lethem-to-Aishalton road

Figure 21. Map showing key areas for wildlife connectivity based on a combination of the models for all 17 species considered



** The text boxes indicate the location of existing bridges. Yak = Yakarintha bridges*

The boundaries and names shown and the designations used on this/these map(s) do not imply the expression of any opinion whatsoever on the part of FAO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers and boundaries. Dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

ular, the area around the Yakarinta bridges, as well as around Bununi and Point Ranch, had the highest probability of connectivity for all species combined. Connectivity through forest, starting at 'Bush Mouth Bridge' was high due to model parameters. Importantly, the new road being constructed at the time of the study, diverting from the GTLR and passing through Yupukari village, also showed a key crossing site for wildlife. In the LAR in central and South Rupununi, the area between Saurab and Sawariwau showed high levels of connectivity. The highest levels were found for Saurab, and for two creeks further south, one near Shulinab village and one near Sawariwau village. In the Deep South, S-Creek and Churikdnau formed narrow connectivity paths across the savannah landscape. Furthermore, the model showed important wildlife corridors between the Sawariwau and Saurab area to Kusad Mountain, a 50 km^2 forested mountain located in the northwest of the south savannahs.

Roadkill and live sightings

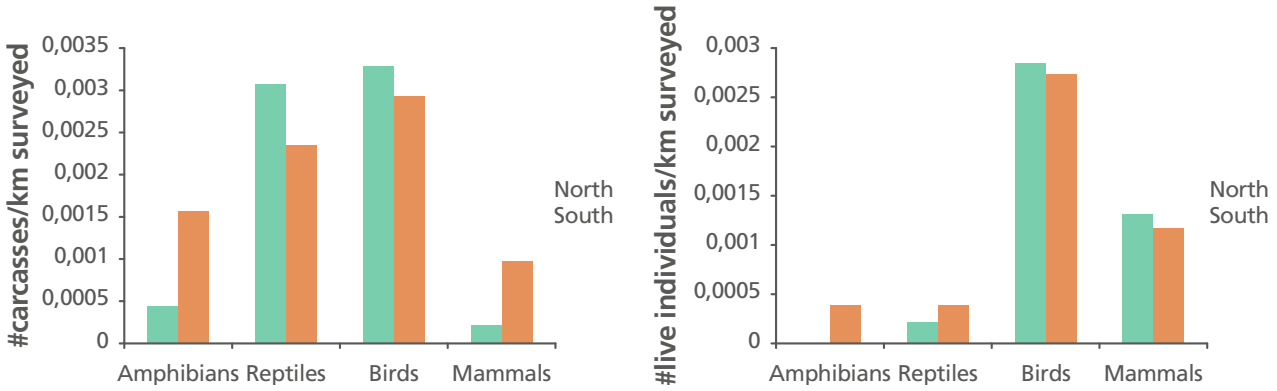
At the time of the study, roadkill was not found to be a major concern for any species. The roadkill pattern will change, however, as traffic volume or road characteristics alter. Roadkill hotspots differ between species, but some general patterns occur. We found an association between roadkill and proximity of water and forest, as seen elsewhere (Freitas, Sousa and Bueno, 2013). On the other hand, we found no association between roadkill and human activity. This may be caused by wildlife avoidance behaviour. Overall, roadkill hotspots were associated with high connectivity areas identified in the landscape analysis.

We recorded 32 carcasses from vehicle collisions along the GTLR, mostly birds (15) and reptiles (14), but also two amphibians and one mammal (see Figure 22). A similar pattern showed along the LAR: 15 birds, 12 reptiles, eight amphibians and five mammals, for a total of 40 carcasses. Roadkill encounter rate per survey day was 0.94 for GTLR and 1.25 for LAR. For every 100 km surveyed, GTLR counted 0.70 carcasses and LAR 0.78. Amphibians were all cane toads (*Rhinella marina*); reptiles included a variety of snake species, an unidentified lizard and one spectacled caiman (*Caiman crocodilus*). Birds could not all be identified, but consisted mostly of ground doves (*Columbina passerine*), quails (*Colinus cristatus*) and nightjars (*Nyctidromus* spp.). Among mammals, the [crab-eating] fox (*Cerdocyon thous*) was the dominant species, but a tayra (*Eira barbara*) as well as a lactating southern naked-tailed armadillo (*Cabassous unicinctus*) were also detected. Small armadillo species, particularly *D. novemcinctus,* are frequent roadkill throughout their range (Silveira Miranda *et al.*, 2017), and therefore are not considered avoiders.

©Luke McKenna
Amazon whipsnake, a roadkill victim, found on the Georgetown-to-Lethem trail

©Luke McKenna
A bird found on the road in North Rupununi

Figure 22. Number of roadkill animals per km surveyed (left), number of live sightings (right) for the GTLR (north, in green) and LAM (south, in orange)



Source: Paemelaere et al. 2023. CIFOR-ICRAF.

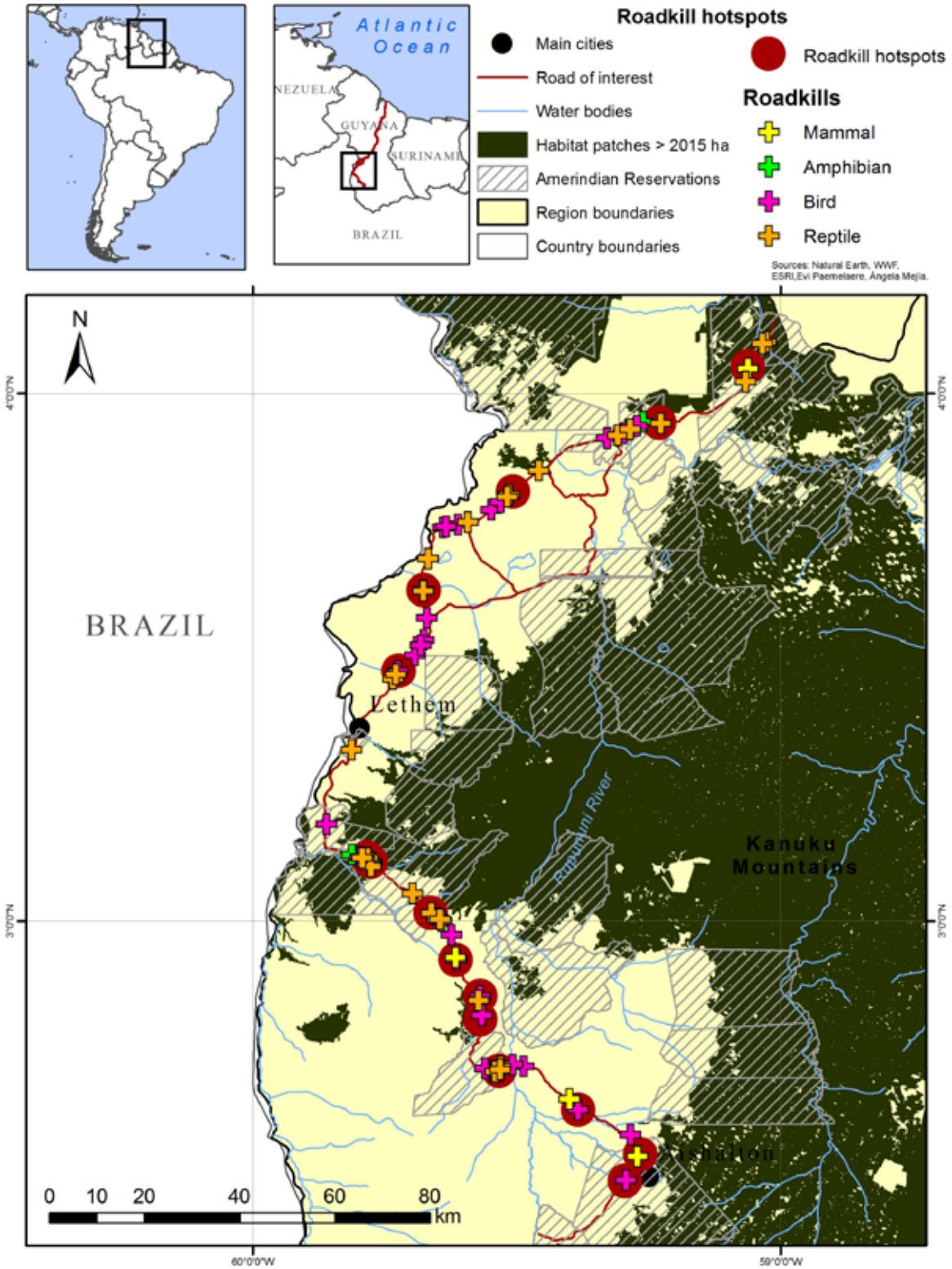
The roadkill hotspot analysis indicated five peak locations along the GTLR (see Figure 23): north of the long Manari bridge, next to the Pirara and Velami bridges, in the Yakarintha area, and near the Bush mouth. Within these hotspots, we recorded a mix of bird and reptile roadkills. The territories in between hotspots were all occupied by human activity (townships, agriculture, village housing along the road). On the LAR, the analysis identified nine hotspots.

Live animals were spotted on the road on 21 occasions for GTLR and 24 for LAR. Seventy-five percent of sightings occurred before 08.00 (see Figure 23). Sightings were mostly birds and mammals, but also a pink-toe tarantula (*Avicularia avicularia*), an unidentified frog, a boa constrictor, a lined ground snake (*L. lineatus*) and an unidentified snake species. Birds included ground birds, such as quail and the scavenging caracara (*Caracara cheriway*). Among mammals, foxes – also scavengers – were most commonly seen. One savannah deer was spotted crossing on GTLR. The giant anteater, sensitive to road impacts and important for local tourism, was recorded even when off-road. Sightings were infrequent on LAR and clustered in the 30 km stretch of road passing through the wetland area on GTLR.

General crossing structure evaluation

The evaluation of bridges and culverts indicated that many bridges need to be lengthened, for a better flow of water underneath and a remaining dry area (see Table 18). Exceptions to this were the long Manari bridge, Pirara and Yakarintha bridges and the bridge at Annai in the north. For the south, the exceptions were Saurab, the large Rupununi bridge and the first small one, and then all bridges south of S-Creek. As for height, Ginnep and Bununi bridges should be built higher. In terms of management, human activity under and near bridges varied, but generally should be limited during at least part of the night to permit a window of time during which animals can adapt as a safe time to use these spaces. Most bridges had natural vegetation underneath and on the sides, which should be maintained in case of upgrades, ideally with a natural bottom surface. In the north, Bush Mouth, Junction and Bununi bridges are key for all species. Pirara, Ginnep and the Yakarintha bridges would mostly serve savannah species. In the South Rupununi, Imatewau, Saurab and the Shulinab and Sawariwau culverts are key for all species, with the culverts requiring an upgrade to bridges to serve this purpose. The small Rupununi bridges are situated in a corridor for mostly savannah species, whereas Churikdnau would serve more forest species. S-Creek was found to be important for giant anteaters.

Figure 23. Roadkill hotspots (red circles) based on a hotspot analysis, and actual roadkill records per vertebrate class (crosses)



The boundaries and names shown and the designations used on this/these map(s) do not imply the expression of any opinion whatsoever on the part of FAO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers and boundaries. Dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

©FAO/Luke McKenna
A giant anteater found crossing the road in North Rupununi

Table 18. List of bridges and two key culverts along the GTLR and LAR with current potential functionality as underpasses, and recommendations for improvement*

	LOCATION		FUNCTIONALITY AS A WILDLIFE UNDER-PASS					CONSIDER-ATIONS		INITIAL RECOMMENDATIONS						Species Priority
Bridge	X	Y	GS	GL	SAQ	Special	Wet sea-son	Town	Corr	L	H	HA	MA	Veg	Other	
GTLR (North Rupununi)																
Manari_ Small	3.43	-59.76	x	x	-	Openness	-	-		x		x		x		
Manari_ Long	3.44	-59.74	x	x	x	Openness, cover (aerial)	-	-	x			x				
Pirara	3.63	-59.68	x	x	x	Openness, cover, (aerial)	-	-	x			x	x			Semi-aquatic, savannah species
Velami	3.83	-59.49	x	-	-	Openness	-	-								
Bunununi	3.87	-59.43	x	-	x	Cover	-	-	x	x	x	x	x			All (less ideal for savannah deer)
Point ranch	3.88	-59.43	x	x	x	Openness	-	-		x					NF	
Toka	3.91	-59.36	x	x	-	Openness	-	-	x	x		x	x	x		
Masara jct.	3.92	-59.32	x	x	-	Openness	-	-		x			x	x		
Ginnip_ Landing	3.94	-59.28	x	-	-	Openness	-	-	x	(x)	x					Savannah species
Yak5	3.94	-59.22	x	x	x	Openness, cover	-	-				x			NF	
Yak4	3.95	-59.25	x	x	-	Openness, cover	-	-								All; better for savannah species
Yak3	3.95	-59.26	x	x	-	Openness	-	-	x				x			
Yak2	3.95	-59.26	x	x	-	Cover, open-ness	-	-	x				x			
Yak1	3.95	-59.26	x	x	-	Openness, cover	-	-								
Annai	3.99	-59.11	x	x	-	Openness	-	x								
Kamodi bash	4	-59.09	x	-	x		-	-	x	x		x		x		
Bush mouth	4.06	-59.06	x	(x)	x	Openness	-	-	x	x			x	x	Cano-py	All
Junction	4.1	-59.03	x	-	x	Cover	-	-	x	(x)			x	(x)		
Mango	4.11	-59.02	x	x	x	(Openness), cover	-	-	x	x						
LAR (South Rupununi)																
Takutu	3	-59.8	x	x	-	Openness; cover	x	x								
Burru	3.3	-59.82	x	-	x	-	-	x	x							
Moco moco	3.35	-59.79	x	x	x	Openness; cover	-	x	x	x						
Kumu	3.32	-59.82	x	x	x	x	?	-		x						
Dingo	3.3	-59.83	x	x	x	cover	x	-								
Macaw	3.29	-59.85	x	-	(x)	-	-	-								
San Jose	3.27	-59.85	-	-	x	-	-	-		(x)						
Najiha	3.25	-59.85	(x)	-	x	-	-	-	x	x						

	LOCATION		FUNCTIONALITY AS A WILDLIFE UNDER-PASS					CONSIDER-ATIONS		INITIAL RECOMMENDATIONS			Species Priority
Najiha 2	3.24	-59.86	-	-	x	-	-	-	x	x			
Spika	3.22	-59.86	-	-	x	-	-	-	x	x			
Imatewau	3.13	-59.81	?	?	?	?	-	-	x	x	x		All
Saurab	3.11	-59.78	x	x	x	Openness; cover	x	-	x		x	Moni-tor	
Saurab_ Small	3.11	-59.78	-	-	x	-	-	-	x	(x)			
Rupununi_ Main	2.73	-59.53	x	x	x	Openness; cover; aerial	-	-	x				
Rupununi_ S1	2.73	-59.52	x	x	-	Cover	-	-					Mostly savannah species
Rupununi_ S2	2.73	-59.52	-	-	x		-	-		x			
A L	2.63	-59.35	x	-	-	Openness	-	-					
"S-Creek"	2.63	-59.35	x	(x)	(x)	Cover	?	-	?			Cano-py	Giant ant-eater, maybe semi-aquatic
Wariwau	2.61	-59.31	x	x	(x)	Openness; cover	?	-			x		
Churkidnau	2.56	-59.27	x	x	-	Openness; cover	?	-	x		x	Cano-py	Forest species
Bridge_02	2.52	-59.28	x	x	-	Openness	?	-			x		
Kabanawau	2.48	-59.32	x	x	x	Cover	?	x	x			NF	
Shulinab cul.	3.05	-59.69	x	-	-	-	-	x		Bridges required to permit all types of species (see text)			All
Sawariwau cul.	2.78	-59.57	x	-	-	-	-	-		All			

Source: Paemelaere et al. 2023. CIFOR-ICRAF

** Structures at priority sites are highlighted. x: applies, (x): may apply, -: does not apply. GS (small generalists), GL (large generalists), SAQ (semi-aquatic species), Special (specialists). Those in or near towns ('Town') have less value; those along well-connected forest habitat ('Corr') have more value. Recommendations: Lengthening needed for free water flow to reduce structural damage and to provide dry area for wildlife (L); Heightening required (H); Human activity needs to be controlled ('HA': e.g. vehicle access, washing, fishing); Debris need to be removed ('MA'); Non-functional due to presence of building on the side (NF). Species priorities are based on the landscape analysis. Savannah species (e.g. savannah deer, giant armadillo, fox), forest species (e.g. powis, jaguar, bush deer, agouti, tapir, monkeys), semi-aquatic species (e.g. capybara, anaconda, caiman, giant otter). All = savannah, forest and semi-aquatic.*

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Pirara bridge – one of the many locations in the camera trap study

Camera trapping

Camera trap effort per structure, calculated as the number of cameras multiplied by the number of sampling days, ranged from 77 (Bush Mouth) to 320 (Saurab). For none of the bridges, the asymptote was reached, indicating that results reported here are only preliminary.

Of 973 independent observations, the majority were signs of human activity (40 percent), mammals (25 percent) and birds (22 percent). The highest relative abundance of terrestrial bird and mammal species was observed at Yakarintha bridge, followed by Ginnep, Churikdnau and Saurab (see Figure 27). Out of 11 of the selected species that can be reasonably detected by camera traps, four were detected at predicted sites: powis, agouti (*Agouti paca*), bush deer (*Mazama* sp.) and giant anteater. Overall, the crossing events were clearly dominated by generalists, although some specialists (arboreal, semi-aquatic) were detected under bridges. Giant anteaters are road-sensitive and classified as non-responders (De Freitas, Justino and Setz, 2014). They approach roads more often than other species, likely due to a connection between roads, fire and food resources.

The connectivity model accurately predicted species types in most cases where structures were deemed adequate (non-highlighted 'X' in Table 19). Conversely, we did not detect predicted crossing species in inadequate structures (highlighted '-' in Table 19). Only the Rupununi bridge and the forest bridges underperformed predictions for terrestrial and semi-aquatic species, respectively (highlighted 'X' in Table 19).

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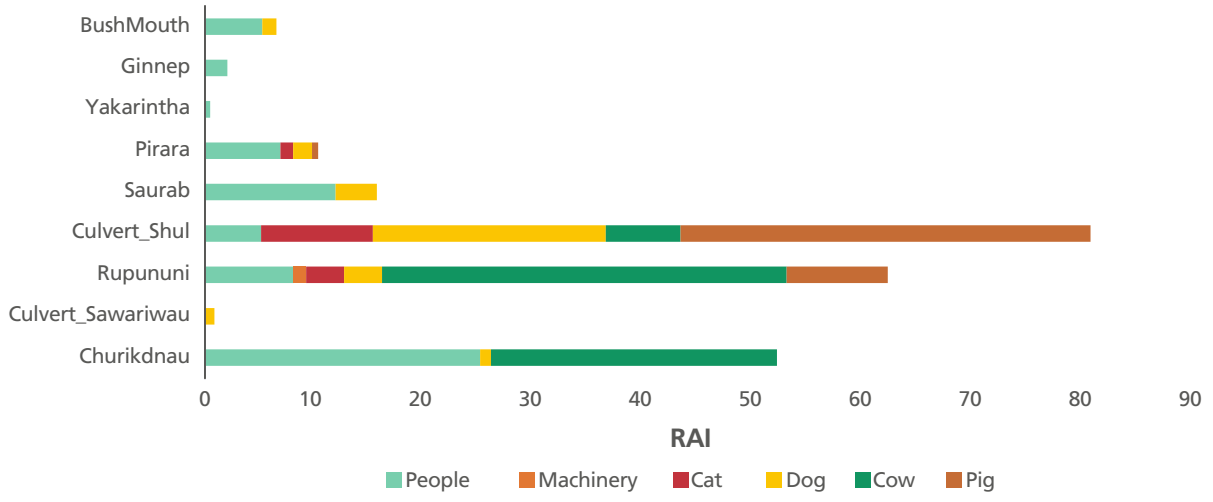
A camera is set at the bottom of Saurab Crossing; a wildlife corridor stretching from the Kanuku Mountains

Figure 24. Right, an ocelot crossing under Yakarintha bridge*

Source: Paemelaere et al. 2023. CIFOR-ICRAF.

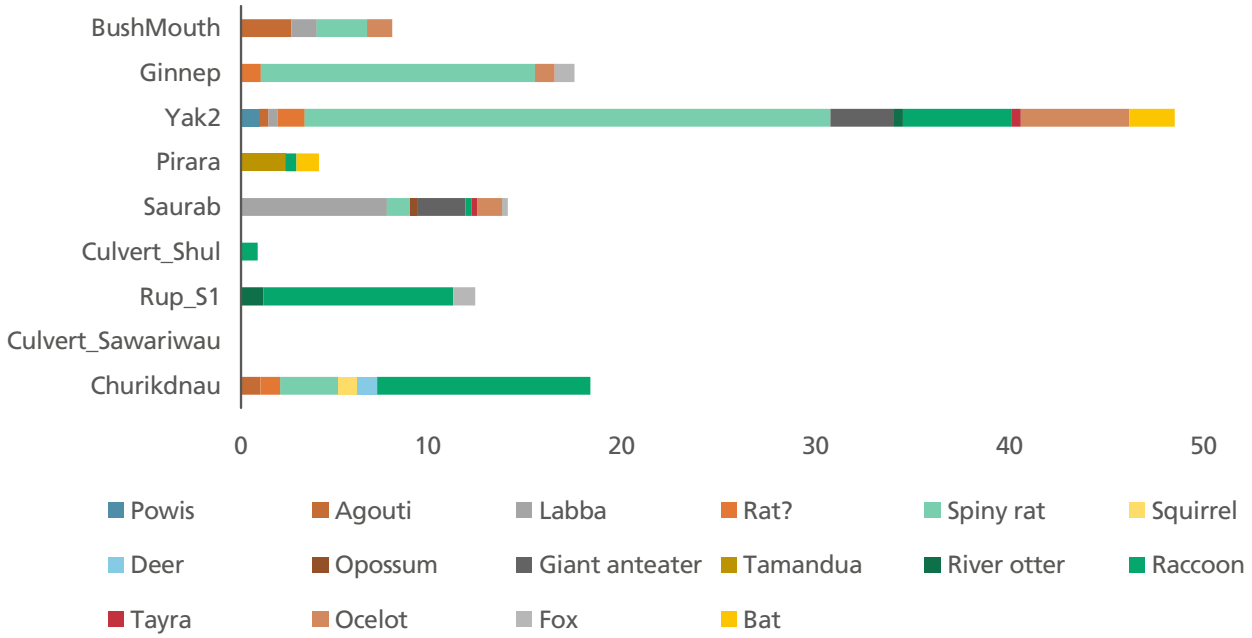
**Ocelots are medium generalists (structural framework) and speeders (behavioural framework). They are adapted to live in human dominated landscapes and run away from danger. On the left, a giant anteater crossing under Saurab bridge. Giant anteaters are medium-large generalists and non-responders. Because of their poor eyesight and slow response time they move in open landscapes and are not deterred by roads.*

Figure 25. Human activity recorded at underpasses



Source: Paemelaere et al. 2023. CIFOR-ICRAF.

Figure 26. RAI of species of interest: powis (*Crax alector)* and all mammals at each site



Source: Paemelaere et al. 2023. CIFOR-ICRAF.

Table 19. Predictions of structures permitting passage of species groups based on structural needs*

	Functionality as a wildlife underpass				Species detected
Structure name	**GS**	**GL**	**SAQ**	**Special**	
Pirara	X	X	X	Openness, cover, (aerial)	Birds, lizards, bat, raccoon, tamandua
Bunununi	X	-	X	Cover, (openness)	NOT EVALUATED (Flooding)
Ginnep	X	-	-	Openness	Fox, ocelot, spiny rat, birds
Yak2	X	X	-	Cover, openness	Birds, lizards, powis, agouti, bat, giant anteater, labba, ocelot, raccoon, spiny rat, tayra
Bush mouth	X	(X)	X	Openness	Birds, lizards, agouti, bush deer, labba, ocelot, spiny rat
Saurab	X	X	X	Openness, cover	Birds, fox, giant anteater, labba, ocelot, opossum, raccoon, spiny rat
Rupununi_S1	X	X	-	Cover	Birds, fox, raccoon, river otter
"S-Creek"	X	(X)	(X)	Cover, arboreal	NOT EVALUATED (Camera failure)
Churikdnau	X	X	-	Openness, cover, arboreal	Birds, lizards, agouti, bush deer, raccoon, spiny rat, squirrel
Culvert_Shulinab	X	-	-	-	Birds, lizards, raccoon
Culvert_Sawariwau	X	-	-	-	Birds

Source: Paemelaere et al. 2023. CIFOR-ICRAF.

**Species detected were used to evaluate the predictions. GS (small generalists), GL (large generalists), SAQ (semi-aquatic species), Special (specialists). Light green cells indicate species structural groups that were not found to cross at the site, but for which corresponding priority species were predicted to have major connectivity pathways through the structure's areas.*

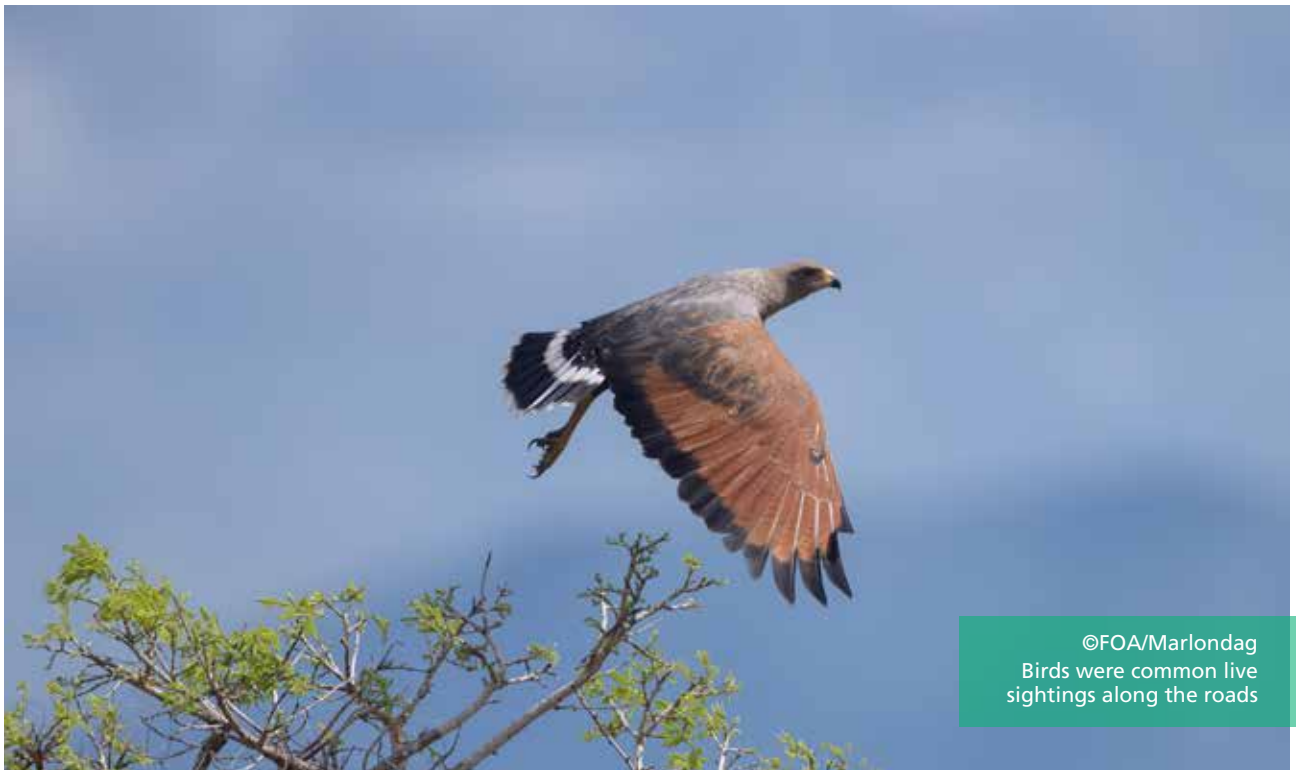
Conclusions and recommendations

In our study we show that theoretical approaches in mitigation of road impact on wildlife and in planning for wildlife friendlier roads are efficient and effective, and they can be used for a wide range of development decisions. In the Rupununi, the many bridges and culverts already present provide excellent opportunities for wildlife crossing and can help keep the roads wildlife friendly (Ruediger and Jacobson, 2013). We identified several priority locations for wildlife connectivity across the studied roads. Bridges at these sites need to be improved or, in case of current culverts, built according to recommendations.

According to our results, upgrades of structures should pay special attention to: 1) adequate length to permit free water flow and ensure dry areas underneath the structure during most of the year; 2) presence of natural vegetation up to the edges and inside of the structures; 3) consideration of canopy bridges or touching canopy for arboreal species; and 4) management of human activity at these specific bridge sites.

The presence of adequate underpasses does not prevent wildlife from entering the road surface, and roadkill can still be expected for non-responders, pausers and speeders, which include most savannah species. In the Rupununi, roadkill and road barriers – for most savannah species – do not represent a major concern as yet. Nevertheless, changing road surfaces or volumes of traffic could alter this, and monitoring is highly recommended. Reporting of roadkill, which may be done through citizen science and a central reporting hub, can help to detect high rates of roadkill of particular species and spot specific dangers to drivers.

The connectivity model presented here is only valid under current habitat and road conditions. Any change, such as expanding large-scale agriculture, urbanization, deforestation or further road construction, will alter the wildlife connectivity patterns and the types of interventions needed to mitigate road impacts. We recommend that the models presented here are used in the planning of such developments to help avoid interruptions of important wildlife corridors.



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Birds were common live sightings along the roads

References

Clevenger, A.P., Chruszcz, B. & Gunson, K.E. 2003. Spatial patterns and factors influencing small vertebrate fauna road-kill aggregations. *Biodiversity Conservation*, 109(109): 15–26.

Coelho, A.V.P., Coelho, I.P., Teixeira, F.Z. & Kindel, A. 2014. *Siriema: Road Mortality Software. User's Guide V.2.0*. Porto Alegre, NERRF, UFRGS. www.ufrgs.br/siriema

Conservation International. 2002. *The Kanuku Mountains Protected Area process: The community resource evaluations*. Georgetown, Guyana.

Fredericks, P., Buckley, C. & Persaud, J. 2016. A natural resource use assessment in the South Rupununi Savannah, Guyana. In: L.E. Alonso, J. Persaud & A. Williams, eds. *Biodiversity assessment survey of the South Rupununi Savannah, Guyana. BAT Survey Report No. 1*, pp. 203–225. WWF-Guianas, Guyana Office. Georgetown, Guyana.

De Freitas, C.H., Justino, C.S. & Setz, E.Z.F. 2014. Roadkills of the giant anteater in south-eastern Brazil: 10 years monitoring spatial and temporal determinants. *Wildlife Research*, 41(8): 673–680. https://doi.org/10.1071/WR14220

Freitas, S.R., Sousa, C.O.M. & Bueno, C. 2013. Effects of Landscape Characteristics on Roadkill of Mammals, Birds and Reptiles in a highway crossing the Atlantic forest in Southeastern Brazil. Paper presented. In: *Proceedings of the 2013 International Conference on Ecology and Transportation*. p. 11.

Jackson, N.D. & Fahrig, L. 2011. Relative effects of road mortality and decreased connectivity on population genetic diversity. *Biological Conservation*, 144(12): 3143–3148. https://doi.org/10.1016/j.biocon.2011.09.010

Jacobson, S.L., Bliss-Ketchum, L.L., de Rivera, C.E. & Smith, W.P. 2016. A behavior- based framework for assessing barrier effects to wildlife from vehicle traffic volume. *Ecosphere*, 7(4): 1–15.

Kintsch, J., Jacobson, S. & Cramer, P. 2015. The wildlife crossing guilds decision framework: a behavior-based approach to designing effective wildlife crossing structures. Paper presented. In: *Proceedings of the 2015 International Conference on Ecology and Transportation (ICOET 2015)*. p. 34044.

Laurance, W.F., Albernaz, A.K.M., Schroth, G., Fearnside, P.M., Bergen, S., Venticinque, E.M. & Da Costa, C. 2002. Predictors of deforestation in the Brazilian Amazon. *Journal of Biogeography*, 29(5-6): 737–748. https://doi.org/10.1046/j.1365-2699.2002.00721.x

Laurance, W.F., Croes, B.M., Guissouegou, N., Buij, R., Dethier, M. & Alonso, A. 2008. Impacts of roads, hunting, and habitat alteration on nocturnal mammals in African rainforests. *Conservation Biology*, 22(3): 721–732. https://doi.org/10.1111/j.1523-1739.2008.00917.x

Ovando, D.A.C. 2008. *Road impact on deforestation and jaguar habitat loss in the Mayan forest*. Duke University. (also available at https://portal.findresearcher.sdu.dk/files/173369019/conde_ovando_2008_phd.pdf).

Pierre, M. & Paemelaere, E. 2018. Wildlife Management Assessment: Region 9 - Upper Takutu - Upper Essequibo, Guyana - Plan of Action for Regional Development (PARD), Region 9. Georgetown, Guyana.

R Core Team. 2020. *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. Vienna, Austria.

Ruediger, W. & Jacobson, S. 2013. Multiple-use crossing structures for providing wildlife habitat connectivity. *Proceedings of the 2013 International Conference on Ecology and Transportation* (Icoet): 14.

Shah, V.B. & McRae, B.H. 2008. Circuitscape: a tool for landscape ecology. In: G. Varoquaux, T. Vaught & J. Millman, eds. *Proceedings of the 7th Python in Science conference (SciPy 2008)*, pp. 62–66.

Sijtsma, F.J., van der Veen, E., van Hinsberg, A. *et al.* 2020. Ecological impact and cost-effectiveness of wildlife crossings in a highly fragmented landscape: a multi-method approach. *Landscape Ecology* 35: 1701–1720. https://doi.org/10.1007/s10980-020-01047-z

Silveira Miranda, J.E., Keichi Umetsu, R., Rodrigues de Melo, F., Silveira Alves Melo, F.C., Pereira, K.F. & Oliveira, S.R. 2017. Roadkill in the Brazilian Cerrado savanna: Comparing five highways in southwestern Goiás. *Oecologia Australis*, 21(3): 337–349. https://doi.org/10.4257/oeco.2017.2103.10

3.3. Coexistence between people, livestock and carnivores in the Rupununi

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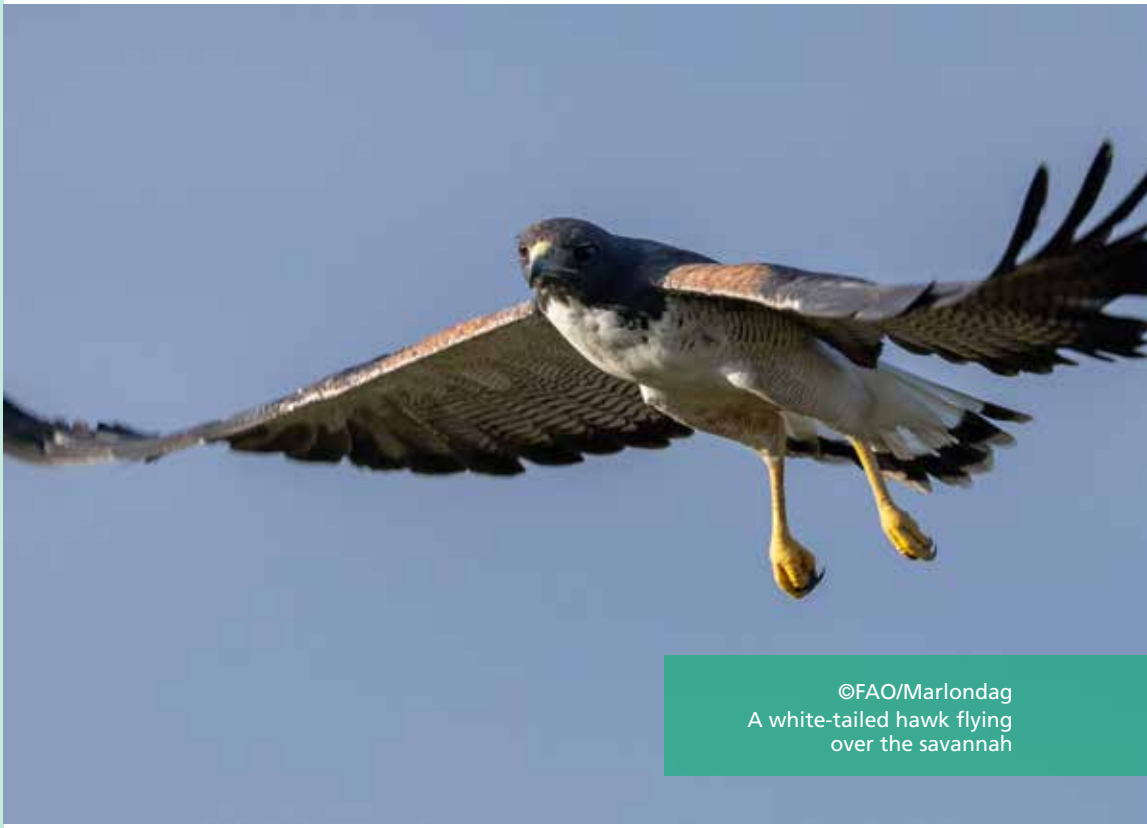
Highlights

- Human–wildlife conflict (HWC) negatively impacts wildlife and the people who live alongside wildlife habitat.
- Retaliatory killing is one of the most pressing issues for large carnivores in the Rupununi region and worldwide.
- Although depredation events on large livestock are not particularly common compared to other regions of the neotropics, they have a negative impact on Indigenous communities whose economic and subsistence livelihoods depend on livestock production, creating a long-lasting negative perception towards large carnivores.
- On the other hand, chickens, owned by the majority of Rupununi residents, are highly vulnerable to depredation by small carnivores, resulting in the loss of an important source of protein and income, particularly affecting women.
- This study aimed at filling in the knowledge gaps around HWC – in particular in relation to the direct predation of large and small livestock by wild carnivores – and at reducing conflict between carnivores and livestock producers.
- Most participants expressed a preference for future growth or stability of large carnivore populations, and viewed conflict as a livestock management issue they can currently resolve with the tools they have access to.



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A white-tailed hawk flying over the savannah

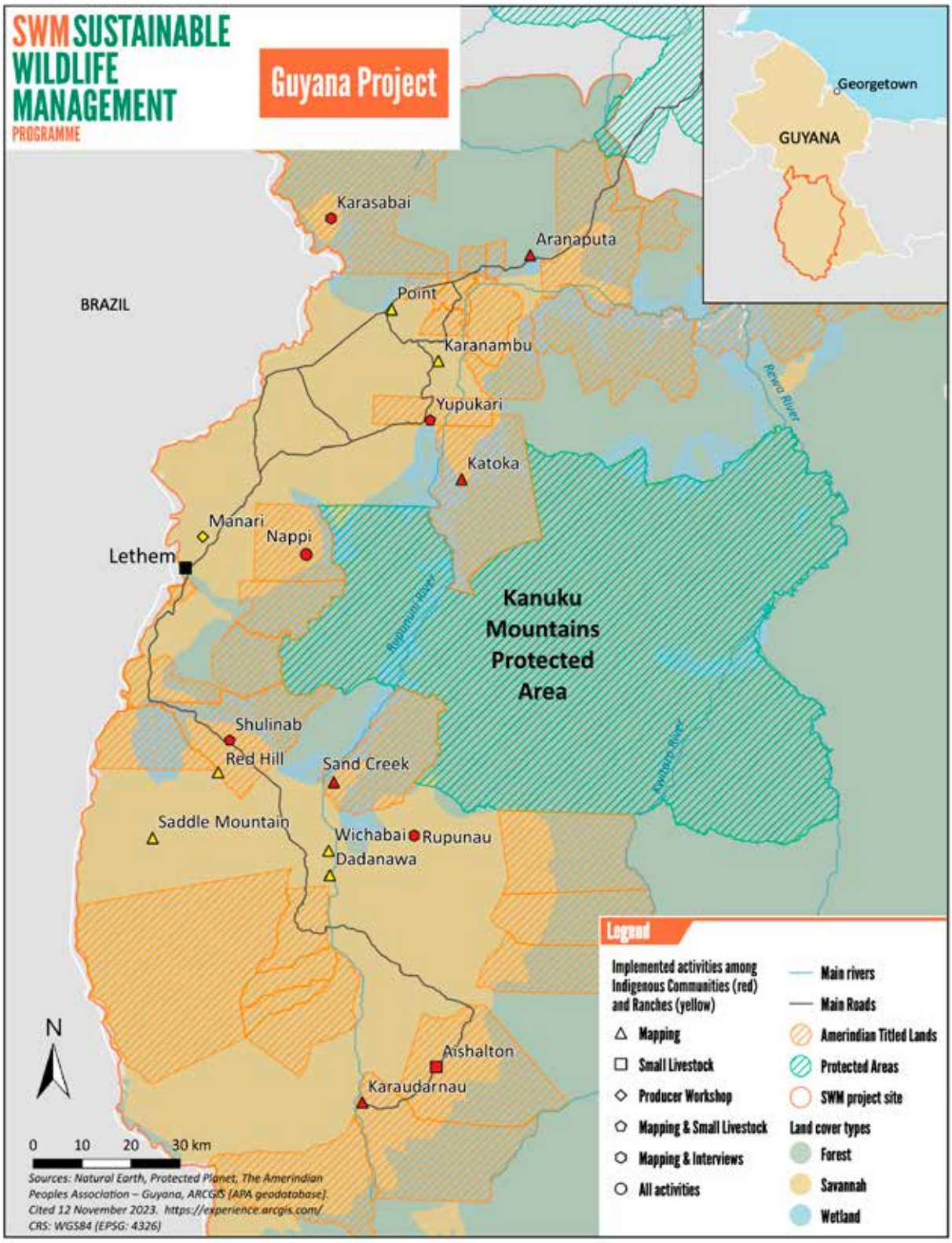
Introduction

Human–wildlife conflict (HWC), occurs when the presence or behaviour of wildlife poses direct threats to human interests or needs, negatively impacting people who live alongside wildlife habitat, leading to disagreements between groups of people and negative impacts on wildlife (i.e. killing of wildlife in an attempt to prevent losses, or in retaliation for losses sustained) (Madden, 2004; Marchini and Crawshaw, 2015; Nyhus, 2016; Gross *et al*., 2021). HWCs not only threaten the persistence of wildlife populations, but also the profitability and effectiveness of livelihood activities and the long-term success of conservation initiatives that rely on the support of local communities (Songorwa 1999; Madden, 2004; Gadd, 2005; Naughton-Treves and Treves, 2005). Retaliatory killing related to HWCs may be among the most pressing issues threatening the survival of large carnivore populations worldwide (Inskip and Zimmermann, 2009; Nyhus, 2016). The notion of coexistence, rather than conflict, is now more widely promoted by the Human–Wildlife Conflict (HWC) Task Force from the International Union for the Conservation of Nature (IUCN) (IUCN, 2020), as it emphasizes the capacity for humans to make choices to share landscapes and natural resources with wildlife in sustainable ways. To do so, coexistence generally also requires agreement – or at the very least, cooperation – between different groups of people about the wildlife in question. In this chapter, we focus on understanding HWC, but frame this knowledge to improve coexistence with wildlife.

HWC can take many forms, but in this chapter, we focus specifically on the direct predation (hereafter 'depredation') of domestic animals such as cattle, horses, pigs, sheep, ducks and chickens; and pets including dogs and cats by wild carnivores (i.e. jaguars, pumas, ocelots, foxes, raccoons, opossums, hawks, snake, and lizards). HWC arises for several reasons the large home ranges of carnivores cause recurrent contact with humans, particularly in areas with extensive livestock management; large carnivore species are specialized for preying on ungulates and will readily kill large livestock when opportunities arise and cattle are an attractive prey, especially in areas where the abundance of natural prey has been reduced by overhunting (de Souza, *et al*., 2018). The abundance of carnivores on the landscape is determined by the amount of suitable habitat, and numbers of mates and prey that are available. Carnivores are inherently at risk of conflict with people because they need to eat meat regularly to sustain their large size and replace calories burned with regular movement across relatively large home ranges (Macdonald and Loveridge, 2010). The most well-known instances of depredation typically involve cattle and large cats such as jaguars and pumas, but a wide variety of smaller carnivores are also responsible for depredation of small domestic animal species such as chicken, pigs and sheep. Depredation of domestic animals, especially chickens, tends to happen more frequently, but depredation events involving larger livestock species (i.e. cattle, horses) carry a much higher cost.

Prey availability plays a particular role in driving or moderating HWC. The introduction of livestock to the landscape can artificially increase the pool of potential prey, and provides an alternative food source when populations of natural prey decline. This may, in turn, escalate conflicts between wildlife and humans (Carbone and Gittleman, 2002). While many carnivores have adaptable diets that allow them to consume a wide variety of species throughout the year, including livestock, their consistent and repeated depredation of livestock is often linked to underlying conditions which drive wild carnivores to turn to livestock more frequently to meet their dietary needs. Climate change, population growth, erosion of traditional culture/beliefs, habitat loss and fragmentation, unsustainable hunting of prey species, uneven sex ratio (male carnivores kill more livestock than females), and skewed age ratios (sub-adult and elderly carnivores kill more livestock) are all factors that have shown to increase HWC with carnivores (Hoogesteijn and Hoogesteijn, 2014; Foster *et al*., 2016; Quigley *et al*., 2018; Petracca *et al.,* 2019).

Figure 27. Map of activity locations, with villages shown in red and private ranches in yellow



The boundaries and names shown and the designations used on this/these map(s) do not imply the expression of any opinion whatsoever on the part of FAO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers and boundaries. Dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Resolving human–wildlife conflict often becomes a contentious issue due to the economic value of the affected resource (i.e. livestock) to humans, and the conservation/legally protected status of the species involved (Treves and Karanth, 2003; McGregor, 2005; Anthony *et al*., 2010). In the Rupununi, concerns over HWC are shared between livestock producers and wildlife conservation advocates. Both groups are impacted negatively, as livestock depredation and retaliatory killing lead to losses for both stakeholders. Cattle have grazed the Rupununi savannahs for hundreds of years and the region once supported some of the largest cattle ranching operations in the world. Today, the largest private ranches have mostly been converted to a mix of cattle rearing and ecotourism. Indigenous communities, on the other hand, incorporated livestock management into the fabric of their culture in the late 1960s, and have since been managing a growing number of relatively small free-ranging herds. Over the last 60 years, livestock production has become an important source of investment and income for Indigenous communities, which otherwise live largely subsistence lifestyles with few alternative income-generating opportunities. So, while the number of cattle lost to carnivores each year in the Rupununi is relatively low compared to large ranches elsewhere in South America, the cost associated with the loss of each individual cow is relatively high, and therefore, the response can be harsh depending on the location, timing and frequency of the event.

To fill gaps in knowledge and attempt to reduce conflict between carnivores and livestock producers, we conducted participatory mapping workshops, cattle producer interviews, and small livestock producer surveys in villages and private ranches of the South Pakaraimas and north, central, south central and south Rupununi, and hosted a centrally-located conflict reduction/mitigation workshop for project participants at Manari Ranch.

Methods

Within this study we engaged with a total of ten communities and seven private ranches (see Figure 27). Communities and ranches were chosen in order to ensure equal distribution across: 1) five major districts of the Rupununi (north, central, south central, south and Pakaraimas) 2) Indigenous communities and private ranches; 3) livestock management strategies (free roaming with no supervision, free roaming with limited supervision, daily free roaming with periodic herding into corrals at night, daily free roaming with daily herding into corrals at night); 4) herd size; and 5) proximity to major habitat types (upland forest, lowland forest, bush islands, gallery forest, savannah). We were limited by permission to conduct activities, presence of cattle, and site accessibility.

Conflict mapping workshops

Following an introduction to the workshop facilitators and an overview of the goals and activities of the study, self-selected participants were guided through an ice breaker activity where they introduced a fellow participant who they had briefly interviewed and found out their name, what species of livestock they manage, how many, and how they manage them. Using visual aids (cards with photos and information about each species), participants worked in small groups to order the livestock cards from the most to least vulnerable to attacks by carnivores (results were coded on a one to ten scale, with ten being the most vulnerable species). The activity was repeated with carnivore cards and participants ranked them from most to least likely to attack their livestock (results were coded on a one to ten scale, with ten being the carnivore species that attacks most often). Colour coded arrows (red = every month, orange = a couple of times a year, yellow = once a year or less) were then drawn between the cards to indicate the predator and prey relationships between each carnivore and livestock species. Lastly, the participants compiled a list of mitigation strategies that they either are using or could use to eliminate or reduce the interactions with red and orange arrows.

In the second part of the workshop, participants worked collectively to create a map of their village or ranch, highlighting: important landmarks not visible on the satellite base maps provided; existing livestock; management strategies such as corrals, paddocks, fences, important feeding and drinking areas for livestock, locations of livestock depredation events that had occurred over the previous two years; and locations of retaliatory killing events that had occurred over the previous two years. Lastly, participants were asked to create lists of the most important issues facing livestock production and farming in the Rupununi. Lists developed by small groups were compiled into one master list, following which participants were given the opportunity to rank each issue as 'very important', 'moderately important' or 'somewhat important'. Issues ranked as 'very important' and 'moderately important' were weighted in their scoring (by multiples of three and two, respectively) and then issues were ranked, with their overall scoring indicating which issues were most important at each site. In the comparison across sites, each score was divided by the total number of points possible at that site (number of participants X three) and then divided by ten (to create a ranking on a one to ten scale).

In total, 191 Rupununi residents participated in the conflict mapping workshops (average = 16 participants/workshop, range = six to 39 participants/workshop) from across the 12 study sites, including eight Indigenous communities, six private ranches, and one neighbourhood democratic council (see Figure 28). The majority of participants were male (n = 108). Male participants heavily outnumbered females at ranch sites in particular.

Cattle producer interviews

We used semi-structured interviews in three communities (Karasabai, Nappi, Rupunau) to better understand livestock producer perceptions of, and responses to HWC. In each household, local research teams interviewed one adult participant, with an average of 49 interviews per village (range: 48–52). We used a convenience sampling approach, as housing within communities was unpredictably arranged, and there were no up-to-date lists of current village members readily available for random sampling. The interviews addressed the following general areas: (1) impacts perceived due to human-jaguar conflict; (2) wildlife stakeholder acceptance capacity and tolerance; (3) risk perceptions about jaguars; (4) guardianship intention with re-

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Cows in a corral

gard to jaguar killing and cattle rustling; and (5) environmental stewardship behaviours. We used visual scales and aids to ensure respondents understood the questions being asked, and to help them to respond accurately (Gore and Kahler, 2015). We conducted a multivariate analysis using linear regression analysis using base R and the "ordinal" package (Christensen, 2018; R Core Team, 2021).

The research team conducted 148 interviews overall in Karasabai, Nappi and Rupunau villages (see Figure 28), between July and August 2021. In total, 57.8 percent of the respondents were males and 42.2 percent females, and participants had an average age of 42.5 (range: 18–89).

Small livestock producer surveys

In each sampled community, the lead researcher and a team of local researchers conducted semi-structured interviews using a computer-assisted personal interviewing (CAPI) technique. Questions examined the types of small livestock reared, the predator species involved in depredation events, the frequency of attacks, as well as current and desired management strategies for conflict reduction. One individual per household with the next upcoming birthday was selected for an interview. This approach was used to control a plethora of individual variables (e.g. age, sex).

Of the 415 people approached for interviews, 403 consented to be interviewed, giving an overall response rate of 97.1 percent. Overall, 100 interviews were conducted in Shulinab, 100 interviews in Yupukari, 102 interviews in Nappi, and 103 interviews in Aishalton (see Figure 28).

Human–wildlife conflict mitigation workshop

The human–wildlife conflict mitigation workshop was hosted at Manari Ranch and was attended by 19 invited participants (16 male, three female) representing eight communities and seven private ranches (out of nine communities and six ranches engaged in the project in total) (see Figure 28). Workshop participants were guided through activities with the goal of identifying key strategies for reducing conflict in the future. Feedback, insights and recommendations proposed and discussed during these activities were recorded by participants and facilitators.

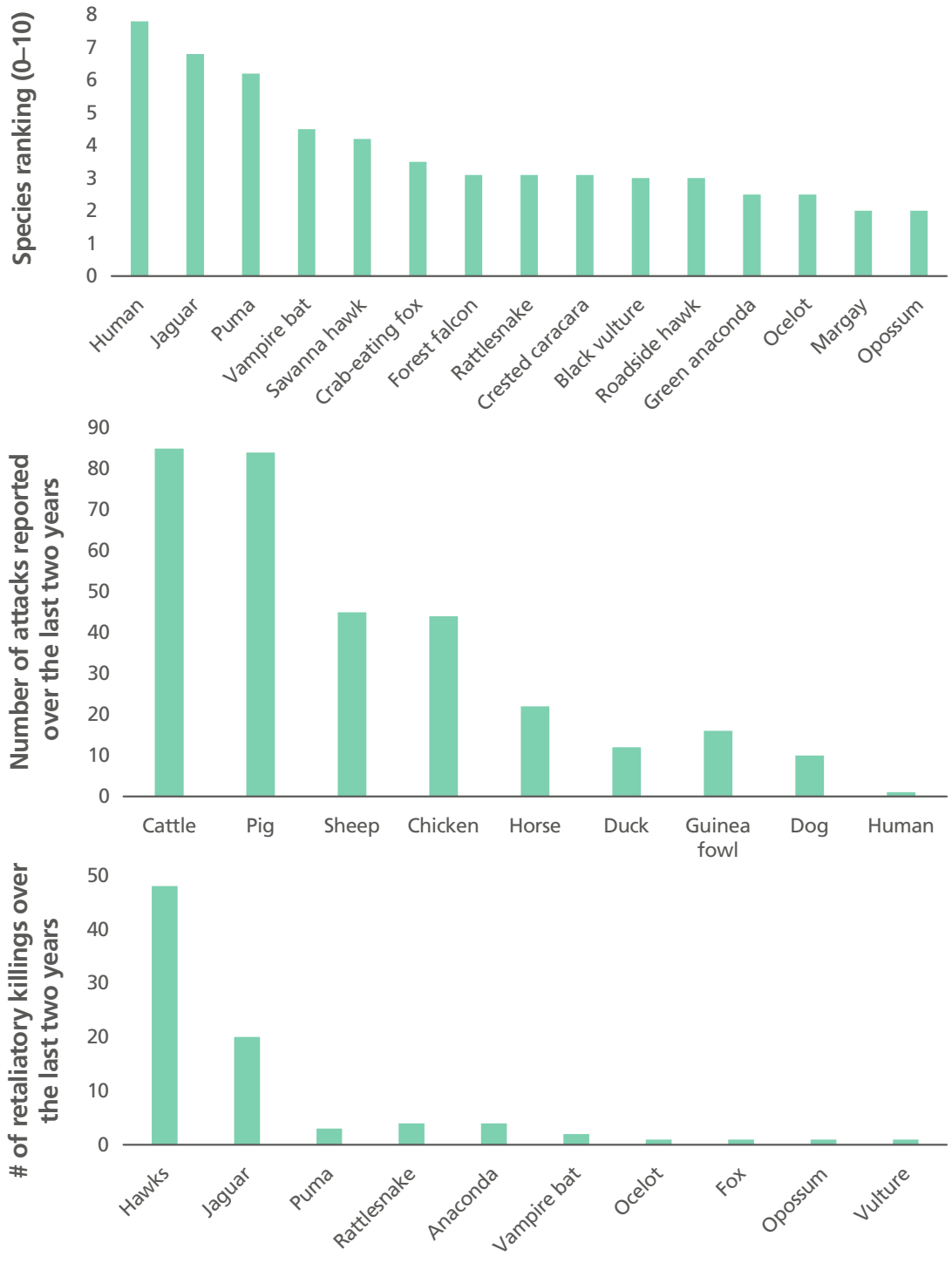
Results

Conflict mapping workshops

Chickens were the domestic species owned by the highest proportion of workshop participants (80 percent), followed by dogs (79 percent), cattle (72 percent), pigs (58 percent), horses (57 percent), cats (40 percent), sheep (37 percent), ducks (30 percent), Guinea fowl (26 percent) and donkeys (six percent). Cattle, horses, donkeys and dogs were reported to be most often managed in free-ranging groups, while pigs and sheep were most often managed as free-ranging groups during the day and then kept in pens during the night. Chickens, ducks and Guinea fowl were allowed to free range in the yard, and cats were primarily kept in the house. Participants identified cattle as the livestock species of highest concern when it comes to attacks by carnivores, followed by chickens, horses, sheep, pigs, dogs, ducks, Guinea fowl, cats and donkeys. Workshops consisting mainly of private ranchers and/or men tended to rank large, free roaming livestock species (cattle, horses, pigs) higher in terms of importance, while groups composed primarily of women routinely ranked smaller, yard or village-based livestock species (sheep, chickens, ducks, Guinea fowl, dogs, cats) higher.

Workshop participants identified humans as the predator that attacks livestock most often (see Figure 28); for example, rustling for direct consumption or sale of the meat), followed by jaguar (tiger), puma (deer tiger), vampire bat, savannah hawk (chicken hawk), crab-eating fox (savannah fox), collared forest falcon, Rupununi rattlesnake, crested caracara, black vulture (Johnny crow), roadside hawk (chicken hawk), green anaconda (camoudi), ocelot (tiger cat), margay (baby tiger), common opossum (yawarie), common tegu (salipenta), yellow-headed caracara, yellow-tailed cribo (yackman), oncilla (tiger cat), spectacled caiman, black caiman (alligator), four-eyed opossum (yawarie) and boa constrictor (land camoudi).

Figure 28. Conflict mapping over time, species*



Source: Authors' own elaboration based on
Hallett, M.T., Pierre, M.A., Kawall, S., Melville, A., Li, F., Kenyon, M., Li, R., de Freitas, K., James, S., Faria, R., de Freitas, J., Casimero, I, Kenyon, J. 2023. SWM Guyana Project Reducing human-carnivore conflict through participatory research. Guyana Wildlife Conservation & Management Commission (GWCMC) and Center for International Forestry Management (CIFOR). Georgetown, Guyana.
**Top figure: average rankings of carnivore species that prey on livestock most frequently (10 = worst offender, 1 = least concern); Middle figure: number of attacks on livestock species over the previous two-year period; Bottom figure: number of retaliatory killing events (by species) over the previous two-year period*

A total of 310 livestock depredation events were documented over the previous two-year period during the conflict mapping activity. Cattle were the target of the most reported attacks, followed by pigs, sheep, chicken, horses, ducks, Guinea fowl, dogs and humans (see Figure 29). Several participants noted that they only reported depredation events they could confirm, but speculated that they lost many more cattle, sheep and pigs (especially young animals) to jaguar and puma attacks because animals roam across a very large area and carcasses are not always found. Additionally, a total of 85 retaliatory killing events were documented over the previous two-year period during the conflict mapping activity. Hawks (including savannah hawk, roadside hawk, collared forest falcon, yellow-headed caracara, crested caracara) were the targets of most retaliatory killing events, followed by jaguar, puma, Rupununi rattlesnake, green anaconda, vampire bat, ocelot, fox, common opossum and black vulture (see Figure 29). In multiple villages where no retaliatory killings of jaguar/puma were reported for the previous two years, residents mentioned failed attempts to kill these species in retaliation for depredation of livestock.

A total of 23 issues important to livestock producers were identified during the workshop. Cattle rustling emerged as the most significant concern among the participants, followed by depredation by wild carnivores, lack of access to veterinary assistance and medication, disease/parasites/pests, and lack of access to markets for products. The full list of issues, and frequency with which each issue was identified as important to livestock producers can be found in Table 20.

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A green anaconda found by the Karaawaimin Taawa team during the biocultural assessment

Table 20. Important issues facing Rupununi livestock producers, their average ranking in terms of importance (10 being most important, 1 being least important), and standard deviation of rankings (higher deviation = more disagreement on the importance of the issue between participants)

Issue	Average rank (out of 10)	Standard deviation
Cattle rustling	8.48	2.85
Depredation by carnivores	7.61	2.77
Lack of access to vet assistance / vet meds	6.42	4.18
Disease, parasites, pests	5.56	4.41
Lack of access to market	5.48	4.17
Drought or flooding	5.13	4.08
Lack of technical assistance, training	5.10	4.79
Lack of access to livestock infrastructure	5.05	4.69
Lack of access to quality grazing grounds	4.35	4.05
Lack of government support	3.68	4.19
Lack of access to pesticides	1.98	3.63
Lack of land security	1.71	3.24
Lack of access to supplemental feed	1.43	3.34
Livestock raiding farms/gardens	1.42	2.44
Savannah fire	1.40	3.10
Livestock drinking cassava water	1.17	2.80
Low quality genetic stock	1.08	2.54
Lack of enforcement of laws	0.83	2.89
Poor road conditions	0.78	2.71
No access to abattoir	0.69	2.40
COVID-19	0.53	1.85

Source: Authors' calculations based on Hallet, M.T., Pierre, M.A., Kawall, S., Melville, A., Li, F., Kenyon, M., Li, R., de Freitas, K., James, S., Faria, R., de Freitas, J., Casimero, I, Kenyon, J. 2023. SWM Guyana Project Reducing human-carnivore conflict through participatory research. Guyana Wildlife Conservation and Management Commission (GWCMC) and Center for International Forestry Research (CIFOR). Georgetown, Guyana.

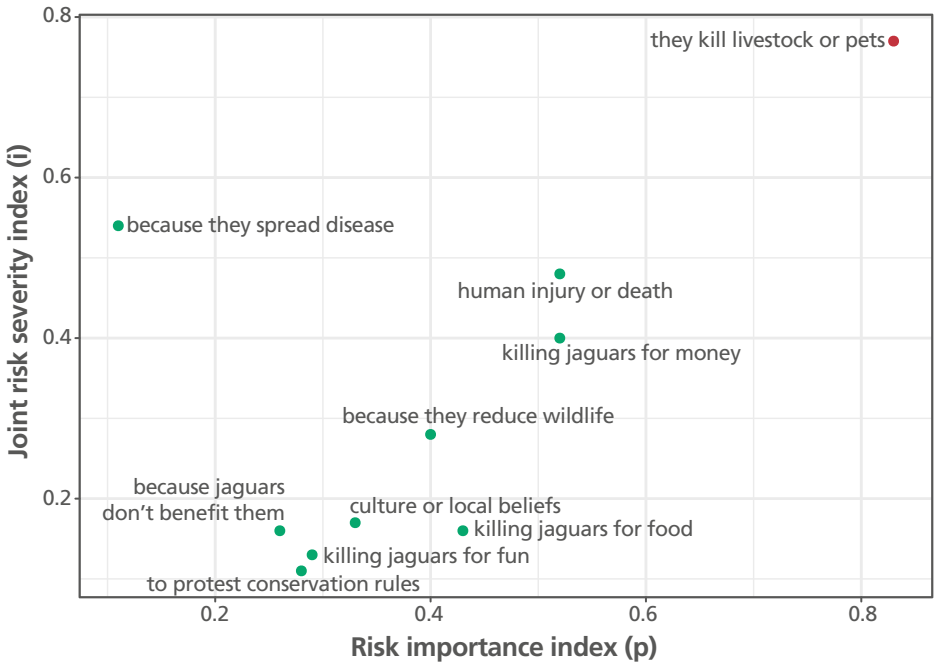
Cattle producer interviews

All interviewees expressed high levels of concern about jaguar attacks. Interviewees assessed the risk of a jaguar attack as 'moderate' and rated their own ability to control risks from jaguars also 'moderate'. Despite these concerns about living with jaguars, most interviewees expressed that they would like to see jaguar populations either grow or remain stable in the future (78.9 percent of respondents overall), as compared to a preference for a decrease in jaguar populations (21.1 percent of respondents). Nevertheless, the desire to live alongside jaguars (tolerance) was not associated with assessments of frequency of jaguar incidents (attacks on people, livestock and pets; $\beta = -0.548$, $p = 0.158$).

In the risk-ranking activity, interviewees identified retaliatory killing of jaguars in response to attacks and losses of humans, pets, and livestock as the most concerning threat to jaguars and the most frequent reason that drives people in the Rupununi to kill jaguars (see Figure 29). Interviewees' worries about attacks from jaguars increased with the number of attacks that interviewees knew of personally ($\beta = 0.160$, $p = 0.004$), but worry was not associated with the number of attacks interviewees had only heard about indirectly ($\beta = 0.014$, $p = 0.363$). Community members' willingness to serve as guardians against retaliatory and preventative killing of jaguars (their willingness and ability to step in to interrupt someone that is planning to kill a jaguar) increased as their tolerance of jaguars increased. Participants' beliefs about the risks posed by jaguars, such as their levels of feelings of control over the risks, increased with their willingness to serve as guardians for jaguars ($\beta = 0.961$, $p = <0.001$). Both sex and age affected participant willingness to serve as guardians, with older men and younger women expressing higher levels of willingness to intervene against negative behaviour towards jaguars ($\beta = 0.016$, $p = 0.033$).

Interviewees' relationships with the would-be offender was important in determining their response to jaguar killing. Participants were more likely to intervene if they did not know the offender personally, and if the offender was not a village member (see Figure 30). Interviewees also expressed higher levels of willingness to respond to jaguar killing and livestock theft as they expressed stronger levels of attachment to their communities and fellow community members ($\beta = 0.453$, $p = 0.017$).

Figure 29. Ranking of possible reasons that people kill jaguars in the Rupununi



Source: Pierre, M.A. 2023. The Conservation Criminology of human-jaguar conflict in the Rupununi Region of Guyana, South America. Master's thesis, University of Florida. Accessed from: https://original-ufdc.uflib.ufl.edu/UFE0060744/00001.

©FAO/SWM
A jaguar captured by a camera trap

Environmental education with Indigenous youth in South Rupununi

By Alyssa Melville, South Rupununi Conservation Society

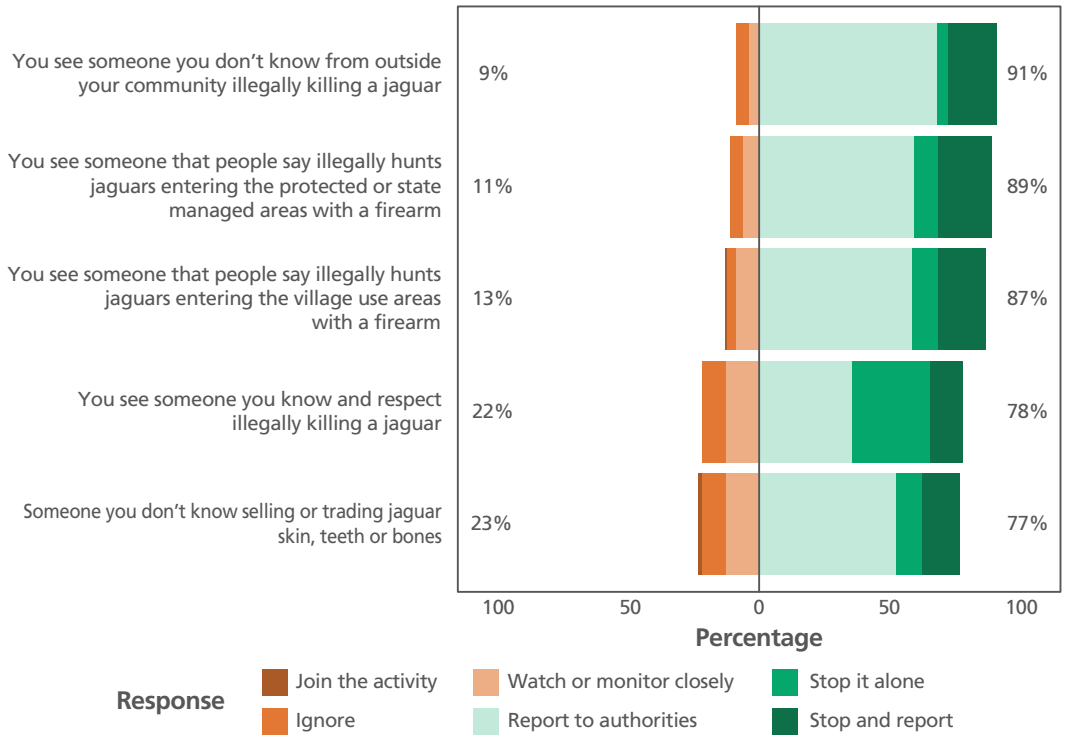
In Guyana's South Rupununi, environmental education initiatives began over a decade ago through the South Rupununi Conservation Society (SRCS) in response to the lack of available activities for local Indigenous youths, especially on wildlife and environmental issues. The SRCS rangers, leveraging their knowledge of birds and their passion for raising awareness, pioneered a series of environmental education activities. As part of this programme, they published a local bird book, created awareness posters concerning endangered birds, and developed birdwatching and nature walks with young children across the South Rupununi.

In 2019, SRCS received support from the SWM Programme to develop and implement an environmental education curriculum tailored for the young people of the Rupununi. The curriculum was developed as a two-year programme targeting primary and secondary school children. The first year of the curriculum focuses on consolidating notions of conservation and sustainable use by linking traditional and scientific knowledge. During the second year, children are taught to become agents of change in their communities through a citizen-science programme. The curriculum is complemented by a variety of engaging activities and products designed to enhance learning, including traditional-knowledge classes, educational videos, nature fairs, ecogames and educational books on wildlife. To date, the programme has reached over 840 youths aged eight to 15 years in 14 communities across the Rupununi. In addition, 56 teachers have received training on how to deliver the programme.

©FAO/Luke McKenna
Students in St. Ignatius village take part in SRCS's Citizen Science Curriculum and Environmental Education Classes

©FAO/Luke McKenna
SRCS exhibition celebrating completion of first year of Shulinab village students' Citizen Science Curriculum

Figure 30. Interviewees' willingness to intervene in various situations involving the killing of jaguars



Source: Pierre, M.A. 2023. The Conservation Criminology of human-jaguar conflict in the Rupununi Region of Guyana, South America. Master's thesis, University of Florida. Accessed from: https://original-ufdc.uflib.ufl.edu/UFE0060744/00001.

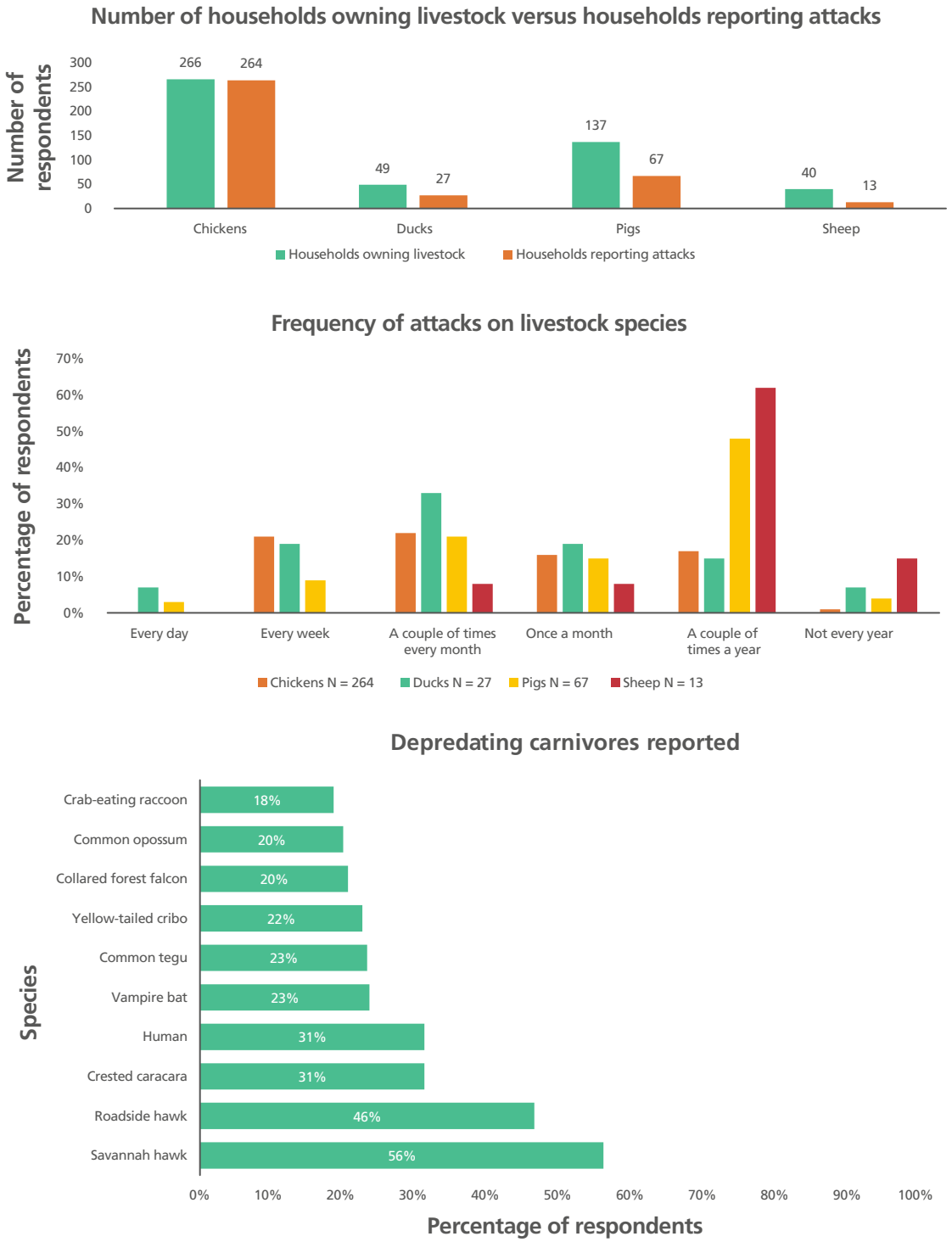
Small livestock producer surveys

Chickens were the most commonly attacked livestock species (reported by 99 percent of respondents), followed by ducks (55 percent), pigs (49 percent) and sheep (32.5 percent) (see Figure 31). Frequency of attacks varied depending on livestock species (see Figure 31). Over 60 percent of chicken-owning respondents reported high frequencies of attacks, with attacks ranging from daily, weekly, to a couple times each month. Similarly, duck owners experienced frequent attacks, while owners of pigs and sheep mainly reported a frequency of a couple of times every year (see Figure 31).

Overall, the most often reported causes of loss were theft by humans and depredating carnivores such as the savannah hawk, roadside hawk, crested caracara, vampire bat, common tegu, yellow-tailed cribo, collared forest falcon, common opossum and crab-eating raccoon (see Figure 31). Most predation events on chickens and ducks were reported to occur in participants' yards, while sheep and pigs were most often predated in the savannah far from their homes. The majority of participants reported witnessing predation events firsthand, though predation on chickens and ducks was much more likely to be witnessed firsthand than on sheep and pigs. When it came to retaliation, more than half of respondents reported trying to kill predators every time an attack happens (the most frequent response). In terms of conflict mitigation for small livestock, more than half of participants recommended the use of improved 'predator resistant' pens, while others suggested fences, increased use of existing pens, feed for livestock, motion activated lights, increased herding of animals, and increased use of guardian animals (dogs).

Workshop participants identified a number of steps and strategies for reducing livestock depredation by wild carnivores in the Rupununi (see Ta-

Figure 31. Results of small livestock producer surveys*



Source: Kawall, S. 2023. Human-wildlife conflict focusing on small carnivores and small livestock in the Rupununi, Guyana. Master of Sustainable Development Practice Field Practicum Report, University of Florida. https://ufdc.ufl.edu/AA00094044/00001/pdf.

**Top figure: number of participants owning livestock and number of participants reporting predation of small livestock by species; Middle figure: frequency of attacks; Bottom figure: most frequently predating species*

ble 21).

Table 21. Steps and strategies identified for reducing livestock depredation by large carnivores (jaguar/puma) in the Rupununi

Steps and strategies
Reduce other stressors (i.e. rustling, loss of other livestock, lack of income) 1. Develop a proposal for a compensation system facilitated by RLPA and maintained by the GWCMC. 2. Address local perceptions of people who kill predators simply because they feel threatened. 3. Control and curb demand from the local and international illegal markets for skins and teeth. 4. Develop alternative sources of income for livestock producers, such as ecotourism. 5. Ensure the proper security of cattle to reduce rustling and predation. 6. Increase enforcement of current laws and increase punishment to deter cattle rustling.
Avoid conflict with large carnivores (i.e. prevent predation of cows) 1. Increase use of good (i.e. more intensive) management practices, such as: a. herding of animals (including potential use of mobile corrals) b. use of corrals/paddocks (especially at night) c. guard dogs d. solar powered motion sensor lights, especially close to villages where predators mainly sneak in at night e. wells and troughs for supplemental water f. provide supplemental minerals (salt blocks) g. provide shade houses h. provide supplemental feed (cows looking for grass can come into contact with carnivores) i. fence farms (cows go into bush islands looking for cassava) j. provide supplemental vitamins and medication (cows go into bush looking for wild yam, bush medicine, leaves, wild garlic, and clay) k. keep cows away from forest edge, bush islands, savannah and far from villages l. identify jaguar hotspots and plan accordingly m. provide cows with treatments for common parasites and diseases (to reduce other sources of mortality) n. provide training to young vaqueros – older more experienced ones should provide training to the next generation.
Reduce desire to kill large carnivores (i.e. increase acceptance of predation of cows) 1. Increase awareness of ecosystem services and the role of large carnivores in regulating and benefitting game species' populations. 2. Identify, trap and relocate any documented repeat offenders (particularly those with noticeable injuries or other impairments).
Reduce culture of retaliation (i.e. reduce belief that killing is the only option) 1. Develop awareness programmes through the school system and wildlife clubs. 2. Provide ranching education and training on carnivore management. 3. Support from lead agency or organization with expertise on jaguars in Guyana (i.e. Guyana Wildlife Conservation and Management Commission (GWCMC), Iwokrama, Protected Areas Commission (PAC), World Wildlife Fund (WWF), Conservation International (CI), Panthera, South Rupununi Conservation Society (SRCS), Rupununi Wildlife Research Unit should support increased awareness, education, actions. 4. GWCMC should assist livestock producers with awareness of rules and laws, and should provide guidance on steps when issues occur by hosting workshops, providing training and support. 5. Improving livestock management (as explained above) should reduce the need for retaliation. 6. Address folklore related to kanaima (kanaimas are shamans that commit evil deeds, and the traditional belief is that they most often take on the form of a jaguar) and jaguars, as well as medicinal use of jaguars and their parts. 7. Address demand for jaguar products, particularly from Chinese markets that may provide incentives to kill jaguars (see Figure 31).
Discourage retaliation as a management tool 1. Educate people on protected species in Guyana, their importance for the ecosystem, strategies for dealing with problematic wildlife, and when it is allowable to kill wildlife to prevent further losses. 2. Educate people and enforce laws with regard to large carnivores. 3. Increase access to markets, and hence, profitability of the livestock industry in the Rupununi – increasing profits overall would reduce the value of each individual animal to make it easier for people to sustain losses. 4. Develop a system for reporting and tracking conflict (i.e. predation and retaliatory killing) to GWCMC (through a mobile app or through reports to the Rupununi Livestock Producers Association RLPA office), and prepare a compensation plan from the government.

Source: Authors' own elaboration based on Hallett, M.T., Pierre, M.A., Kawall, S., Melville, A., Li, F., Kenyon, M., Li, R., de Freitas, K., James, S., Faria, R., de Freitas, J., Casimero, I, Kenyon, J. 2023. SWM Guyana Project Reducing human-carnivore conflict through participatory research. Guyana Wildlife Conservation and Management Commission (GWCMC) and Center for International Forestry Research (CIFOR). Georgetown, Guyana.

Discussion

This study aimed at filling knowledge gaps about HWC in the Rupununi, and at identifying strategies for reducing and mitigating conflict between livestock producers and large and small carnivores.

Filling gaps in knowledge on conflict

Workshops, interviews and surveys conducted during this study showed the Rupununi livestock producers have an intricate knowledge of the movements and habits of their livestock, the distribution and seasonality of important resources, and the needs for improving the management of their animals. There was broad acknowledgement that the Rupununi can be a harsh environment for raising livestock: it is very hot and dry during certain times of the year, very wet and flooded at other times, the grasses are nutrient poor, and parasites and diseases can be rampant. Despite all this, cattle have adapted wonderfully to the environment and are able to locate the resources to meet their needs by roaming far and wide across the landscape. However, free roaming cattle are also more susceptible to carnivores, and restricting the movement would require more intensive livestock management (and corresponding resources and capacity building). Participants in multiple activities indicated that livestock producers from the region would benefit from educational opportunities targeted at filling knowledge gaps about why large carnivores and particularly jaguars are important for the landscape, what role they play in maintaining healthy populations of game species, and why they leave their forest habitats.

Conflict mapping workshops were well attended except for those held at ranches because of the lower number of people residing at these locations. Workshops in ranches were also heavily skewed towards male participants and issues related to cattle (their primary business). Workshops that took place in villages tended to have a more gender balanced participation, and thus responses were more broadly representative of the issues facing the region. Workshops with more female participants tended to focus more on small livestock that are managed close to the home and the small carnivore species that prey upon them. Across all workshop sites, chickens were the most commonly owned livestock species and also the one most fre-

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Local poultry farmer, Flora Gomes, shows her produce

quently preyed upon by a wide suite of wild carnivores. Though the attention is often focused on cattle and large carnivores, depredation of poultry is a much more pervasive issue. Because of this, we decided to conduct follow up surveys that focused specifically on poultry.

The small livestock producer surveys indicated that the majority of Rupununi residents own chickens, and increasingly depend on them as a protein source. Depredation of chickens by small carnivores (mainly birds of prey, tegus, snakes, opossums) is much more common and widespread than any other type of conflict and is usually witnessed in person in the yards of village residents. Experiencing frequent and persistent depredation that results in the loss of an important source of protein and income leads to frustration towards, and tension with, wildlife. A number of survey participants remarked that depredation on chickens occurs quickly and when/where you are least expecting it, which makes prevention and retaliation difficult. Theft of chickens by humans, either for consumption or sale of live animals and meat, only adds to the economic loss and frustration related to managing poultry. Depredation of chickens particularly affects Rupununi women, who often look after chickens (and ducks) close to their homes, and may derive income from the sale of meat and eggs in the village or to hot meals programmes. Reducing conflict between small carnivores and small livestock through the adoption of improved, 'predator resistant', chicken pens has the potential to support women's empowerment, local enterprise, and a sustainable source of protein.

Cattle remain an important part of the culture and the economy of the Rupununi. Data from our conflict mapping workshops indicate that depredation of cattle by jaguars and pumas is by no means a frequent event (happening only a couple of times per year, if at all). However, these events remain very important in the relationship between Rupununi people and the region's largest carnivores. The 21 instances of jaguars being killed in retaliation for killing livestock across 12 sites, when extrapolated across the Rupununi region (approximately 44 villages), amounts to an estimated 70 or so jaguars killed over a two-year period. This level of conflict and retaliatory action is likely not sustainable in the long term. Certainly, some proportion of these carnivores are old, sick or injured individuals, and their removal from the population is not at a great detriment because they had either already contributed to the gene pool or were otherwise incapable of doing so. However, there is also likely a relatively high number of reproductive individuals that are removed from the population, potentially including nursing females. Our cattle producer interviews indicated that participants expressed high levels of concern in relation to jaguar attacks on cattle, but assessed the risk of a jaguar attack as 'moderate'. Participants rated their own ability to control risks from jaguars also 'moderate'. Our data shows a correlation wherein older men tend to hold a stronger belief in their capacity to intervene in instances of retaliatory killings. However, community members' willingness to intervene in these circumstances also depended on the strength of their relationships with other community members (i.e. social cohesion).

The positive outcomes of this study were that most participants expressed a preference for future population growth or stability of large carnivores; that nobody takes pleasure in the retaliatory killing of jaguars; and that the vast majority of participants viewed conflict as a livestock management issue they can currently resolve with the tools they have access to. Participants understood that killing a carnivore does not solve the problem, but also acknowledged that it does potentially relieve some immediate pressure and provide some relief in a landscape where livestock represent a primary source of income. Participants identified a total of 23 important issues facing livestock producers, of which the most important was cattle rustling, and the second most important was depredation by wild carnivores. Improving livestock management seems to be the primary way forward, not only for reducing conflict with jaguars and pumas, but also for improving the livestock products of the Rupununi and the livelihoods of its people.

Reduction and mitigation of conflict

Data collected over the course of the project indicated that rustlers and large carnivores (ironically referred to as 'two foot' and 'four foot' jaguars) were linked by the fact that both are enabled by free roaming cattle management (cows are at higher risk when they are allowed to stray). While participants agreed that the strategies for reducing cattle losses resulting from both issues were similar, they were skeptical that reducing losses to rustling would automatically reduce retaliatory responses to livestock depredation. It appears that the frustrations associated with each source are unique, and only reducing the losses associated with each specific source will reduce the associated retaliation. In fact, although livestock depredation events are far less common than cattle rustling, they were ranked as being nearly as significant or sometimes more significant in terms of challenges faced by livestock producers. While cattle rustling may also be reduced by some of the strategies that would help address conflict with large carnivores, we recommend that this issue should be handled separately by the relevant agencies such as RLPA Guyana Livestock Development Authority (GLDA) and the Ministry of Agriculture.

Workshop participants identified a suite of strategies for reducing human-carnivore conflict that could be implemented in the future. These strategies all fall under the category of improved or 'semi-intensive' livestock management. There was broad acknowledgement by workshop participants that livestock depredation (and also cattle rustling) is facilitated by the wide-ranging nature of Rupununi cattle. Allowing cattle to roam far away from communities, into areas that are not frequented by people, along forest edges, or into the forest (or near main roads in the case of rustling) clearly makes cattle vulnerable to depredation. While jaguars frequent areas close to villages and ranches, participants viewed these instances as rare or special cases where individual animals are desperate (due to injury, sickness or the demands of nursing young). Participants identified that it is when cattle roam away from human habitations (noise, lack of cover, and direct hot sunlight are all factors that deter jaguars/pumas) and go near or into the forest in search of resources, that they are most vulnerable. It was widely acknowledged that Rupununi soils and grasses are poor, and water can be scarce in the dry season. Workshop participants explained that cattle roam in search of supplemental minerals and vitamins (from browsing on forest plants or eating riverine clay) and water from natural sources that run from the region's forested mountains.

Keeping cattle away from these areas where they are most vulnerable would require the provision of water and supplemental food/minerals in areas that are closer to villages and ranches in the open savannah (see Table 20). 'Model' ranches, in terms of reducing conflict with jaguars, would include access to salt blocks, vitamins and supplemental feed that would provide cattle with a more complete diet. A well would provide a year-round source of water in the open savannah. Cattle seek shelter from the direct hot sun in the forest, so a 'model' ranch would also benefit from providing an artificial shelter that would provide shade to animals while they rest during the day. A 'model' ranch would also benefit from a proper corral/paddock that would allow animals to be safely contained during the night. Corrals would also benefit from the installation of motion sensor lights or noisemakers, along with well-trained cattle dogs, that would help to deter any potential predators (two-foot or four-foot jaguars). A chute (a corral with a funnel leading to a holding pen) would also allow ranchers to safely handle their animals while conducting inventories or providing vaccines, dewormers or other treatments.

Workshop participants also indicated that they would benefit greatly from further research into Rupununi cattle (GPS tracking, assessments of optimal stocking density and forage) and the development and maintenance of a reporting and compensation system for depredation events by jaguars and pumas. A mobile application that could populate a conflict database maintained by the RLPA seems to be the ideal tool for providing

such as service. Ideally, in the long term, this database would be used to pay out compensation (either from government, private or NGO funders) for thoroughly documented depredation events.

Lastly, our results support the notion that community members can serve as key participants in managing and mitigating conflict with carnivores, especially in the face of low formal enforcement capacity, such as the ability of the police to respond to incidents regarding jaguars. Worry about the perceived risk of living alongside jaguars must be addressed through efforts that address damages caused by carnivores; and developing systems for managing relationships between community members, and community members feelings of ownership towards jaguar populations on their titled lands. Although human–jaguar conflict is a concern, our results demonstrate that it can be addressed in the Rupununi by building capacity to improve livestock management and developing systems and structures to support Rupununi livestock producers.

References

Anthony, B.P., Scott, P. & Antypas, A. 2010. Sitting on the fence? Policies and practices in managing human-wildlife conflict in Limpopo Province, South Africa. *Conservation and Society*, 8(3): 225–240.

Carbone, C. & Gittleman, J.L. 2002. A common rule for the scaling of carnivore density. *Science*, 295(5563): 2273–2276.

Christensen, R.H.B. 2018. *Cumulative link models for ordinal regression with the R package ordinal*. Submitted in J. Stat. Software, 35.

de Souza, J.C., da Silva, R.M., Gonçalves, M.P.R., Jardim, R.J.D. & Markwith, S.H. 2018. Habitat use, ranching, and human-wildlife conflict within a fragmented landscape in the Pantanal, Brazil. *Biological Conservation*, 217: 349–357.

Foster, R.J., Harmsen, B.J., Macdonald, D.W., Collins, J., Urbina, Y., Garcia, R. & Doncaster, C.P. 2016. Wild meat: A shared resource amongst people and predators. *Oryx*, 50(1): 63–75.

Gadd, M.E. 2005. Conservation outside of parks: attitudes of local people in Laikipia, Kenya. *Environmental Conservation*, 32(1): 50–63.

Gore, M.L. & Kahler, J.S. 2015. Using visual scales in researching global human dimensions of wildlife. *Human Dimensions of Wildlife*, 20(2): 159–166.

Gross, E.M., Jayasinghe, N., Brooks, A., Polet, G., Wadhwa, R. & Hilderink-Koopmans, F. 2021. *A Future for All: The Need for Human-Wildlife Coexistence*. WWF, Gland, Switzerland.

Hoogesteijn, R. & Hoogesteijn, A. 2014. *Anti-predation strategies for cattle ranching in Latin America: A guide.* Panthera, Brazil.

Inskip, C. & Zimmermann, A. 2009. Human-felid conflict: a review of patterns and priorities worldwide. *Oryx*, 43(1): 18–34.

IUCN. 2020. *IUCN SSC Position Statement on the Management of Human-Wildlife Conflict*. IUCN Species Survival Commission (SSC) Human-Wildlife Conflict Task Force. Gland, Switzerland.

IUCN. 2023. *IUCN SSC guidelines on human-wildlife conflict and coexistence: first edition*. IUCN Species Survival Commission (SSC) Human-Wildlife Conflict Task Force. Gland, Switzerland.

Macdonald, D. & Loveridge, A. eds. 2010. *The biology and conservation of wild felids*. Vol. 2. Oxford University Press.

Madden, F. 2004. Creating coexistence between humans and wildlife: global perspectives on local efforts to address human–wildlife conflict. *Human dimensions of wildlife*, 9(4): 247–257.

Marchini, S. & Crawshaw Jr., P.G. 2015. Human–wildlife conflicts in Brazil: a fast-growing issue. *Human Dimensions of Wildlife*, 20(4): 323–328.

McGregor, J. 2005. Crocodile crimes: People versus wildlife and the politics of postcolonial conservation on Lake Kariba, Zimbabwe. *Geoforum*, 36(3): 353-369.

Naughton-Treves, L. & Treves, A. 2005. Socio-ecological factors shaping local support for wildlife: Crop-raiding by elephants and others. *People and Wildlife, Conflict or Co-existence?*, (9)252. Cambridge University Press.

Nyhus, P. J. 2016. Human–wildlife conflict and coexistence. *Annual review of environment and resources*, 41: 143–171.

Petracca, L.S., Frair, J.L., Bastille-Rousseau, G., Hunt, J.E., Macdonald, D.W., Sibanda, L., & Loveridge, A. J. 2019. The effectiveness of hazing African lions as a conflict mitigation tool: Implications for carnivore management. *Ecosphere*, 10(12): e02967.

Quigley, H., Hoogesteijn, R., Hoogesteijn, A., Foster, R. J., Payan, E. & Urbina, Y. 2018. Observations and preliminary testing of jaguar depredation reduction techniques in and between core jaguar populations. *Parks*, 21(1): 63–72.

R Core Team. 2021. *R: A language and environment for statistical computing*. Published online 2020.

Songorwa, A.N. 1999. Community-based wildlife management (CWM) in Tanzania: Are the communities interested? *World Development*, 27(12): 2061–2079.

Treves, A. & Karanth, K.U. 2003. Human-carnivore conflict and perspectives on carnivore management worldwide. *Conservation Biology*, 17(6): 1491–1499.

3.4. Wild meat demand from urban areas on the coast of Guyana and how it may impact wildlife in the Rupununi

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Highlights

- The market chain on the coast of Guyana is short and direct, where the harvester often sells directly to the consumer or through a single intermediary (market vendors, home-based traders, roadside traders, restaurants, food stalls or rum shops).
- Wild meat in urban areas of coastal Guyana is considered a cultural food, rather than a necessity: the price is higher compared to other meat sources and demand rises for special events and weekends.
- Although the bulk of the wild meat volumes sold on the coast of Guyana involves mostly non-endangered species (labba, bush deer and peccaries), vulnerable species such as tapirs are also traded.
- The volume of wild meat traded on the coast of Guyana annually is estimated to be around 361 tonnes. Considering the population size on the coast, this amount translates to 1.4 g per capita per day, which accounts for approximately four percent of the protein intake from animal origin.

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A vendor in Georgetown with wild meat for sale

Introduction

Over the last few decades, hunting has evolved from a purely subsistence activity to a semi-commercial or commercial activity for local communities in tropical areas. This shift has generated value across trade chains from the forest to urban areas, and significantly contributed to household income and to a growing food demand from urban populations in the tropics (Ingram *et al*., 2021). In the neotropics, wild meat consumption and trade have long been considered of minor importance and more associated with rural or Indigenous communities, rather than with urban environments (Rushton *et al*., 2005; Nasi *et al*., 2011). However, recent research focusing on the Amazon region has shown that volumes of wild meat consumed in urban areas are not negligible (van Vliet *et al*., 2014). In fact, estimates suggest that the overall consumption of wild meat in urban areas in Amazonia amounts to thousands of tonnes annually (Carignano Torres *et al*., 2022). These studies have demonstrated that supply chains from hunters to markets are well structured (El Bizri *et al*., 2020; van Vliet *et al*., 2022), and that social networks play an essential role in the exchange of wild meat (Carignano Torres *et al*., 2021). Urban populations exert particular pressure on three preferred species: the lowland paca (*Cuniculus paca*), Brazilian tapir (*Tapirus terrestris*) and white-lipped peccary (*Tayassu pecari*) (Carignano Torres *et al*., 2022), but consumption patterns vary according to ethno-linguistic culture (van Vliet *et al*., 2014; de Araujo Lima Constantino *et al*., 2021). Aquatic species are also targeted, such as the South American giant river turtle (*Podocnemis expansa*) which is harvested for meat, eggs and oil (Peñaloza *et al*., 2013).

Despite being considered a local delicacy, little is known about wild meat consumption and trade in the Caribbean and Guiana Shield region (Richards-Greaves, 2013). Literature shows that hunting plays a socially cohesive role in Jamaica (Gibson, 2020) and continues to be part of subsistence strategies in both Creole and Indigenous communities in the Caribbean (Pacheco-Cobos and Winterhalder; 2021). Some species play a key cultural role, such as the mountain chicken frog (*Leptodactylus fallax*) in Dominica (Nicholson *et al*., 2020). In Belize, gibnut (labba, lappe or paca; *Cuniculus*

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A fisher shows his catch, a giant river turtle

paca) and red brocket deer (*Mazama americana*) are among the most preferred types of wild meat (Jones and Young, 2004). While wild meat in the Caribbean region is known to be a speciality dish (Richards-Greaves, 2013), and recipes such as curry labba, stewed agouti (*Dasyprocta* sp.), and coconut curry wild meat are widely found on the Internet, the extent of its trade and consumption in urban markets, as well as related supply chains, remains largely unknown.

In this study, we investigated the demand for wild meat from urban areas on the coast of Guyana and its impact on wildlife in the Rupununi region. In Guyana, wildlife use is regulated under the Wildlife Conservation Management and Sustainable Use Regulations from 2019, through a licensing system for hunting, trapping, collecting and commercialization of wildlife. These regulations have not been fully implemented, and therefore, the sector remains mostly unregulated. Unlike Brazil or Colombia, where the regulation clearly bans wild meat trade (van Vliet et al., 2019), trade and consumption openly occur in Guyana. In this study, we describe: 1) the structure of the trade chain, including the direction of flows, the species and volumes traded; 2) the food safety and handling practices associated with wild meat trade; and 3) the consumption patterns, with a focus on identifying the household characteristics that determine wild meat consumption.

Methods

Prior to data collection, we conducted a comprehensive survey to identify all possible wild meat sale points in both urban and peri-urban areas located on the coast of Guyana. Given the legality of the trade at the time of the study, we did not encounter any obstacles in identifying wild meat vendors. We began our stakeholder identification process by using a preliminary list of wild meat vendors provided to us by the Guyana Wildlife Conservation and Management Commission (GWCMC). The list included both vendors selling raw wild meat and those selling meals with wild meat. To supplement the list, we conducted an online search for wild meat sales. Between May and July 2019, we identified and visited all vendors, conducting structured interviews or scheduling subse-

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Wild meat being cooked at a camp in the Karaawaimin Taawa

quent visits depending on the vendor's availability.

The interview was structured around four topics. The first section inquired about the vendors' socioeconomic characteristics (ethnic group, age, gender, main economic activities of the owner). The second section inquired about the sourcing of wild meat (origin, supplier, regularity, potential agreements in place with supplier). The third section concerned the wild meat sold (top five species sold, hunting method, state of the meat – such as fresh, frozen, smoked, salted – and volume sold). Finally, we asked about food safety and handling methods. To estimate the total amount of wild meat sold per month, assuming a steady trade throughout the year, we multiplied the average daily amount of wild meat sold by raw meat vendors by the number of days per month spent in the business and multiplied by 12 months. The sum of this value for all raw meat vendors resulted in an estimate of total biomass of wild meat extracted and sold per year on the coast of Guyana.

To assess wild meat consumption in urban areas, we conducted consumption surveys via phone and online platforms between 2020 and 2021. Firstly, we generated a randomized list of phone numbers based on the Guyana phone directory. Then, we selected one percent of households in all the main towns across the coastal regions and contacted them. To ensure standardized interview protocols, we trained four assistants through multiple group and personal sessions. Phone numbers were assigned randomly to the assistants.

Surveys were designed as semi-structured interviews, with a mix of closed and open questions. Part of the survey included demographic questions: location of the household (town and region), number of male and female adults, self-identified ethnicities, religion(s), and indicators of wealth (type of transportation and living in a rented or owned home). To assess the use of animal protein in the diet, we included questions about consumption of fish and meat. We then asked interviewees whether they consumed wild meat, and how often they did so, as well as which species they consumed. For households that reported consuming wild meat, we asked how they obtained it, with options such as hunting (by anyone in the household), receiving it as a gift, buying it, or other. If purchased, we further asked if they obtained it from a market, a meat shop, directly from a hunter, at a restaurant, or other. Finally, we asked consumers what they valued about wild meat, while non-consumers were asked about the reasons for not eating wild meat. Respondents were allowed to list multiple values, which were then categorized.

To investigate the influence of household characteristics on wild meat consumption patterns we ran an ordinal logistic regression analysis. Explanatory variables included the location of the household (rural or urban), presence of a man in the household, presence of a hunter in the household, household size, ethnicity, religion and wealth. To obtain the wealth indicator, we scored transportation (car or pickup truck: 3, motorbike: 2, non-motorized: 1, no own transportation: 0) and home ownership (own home: 2, rent home: 1, or other: 0). Both scores were summed and scores of 0–1 were ranked as 'low', 2–3 as 'medium' and 4–5 as 'high'. Categorical data were factored, and the variables wealth and frequencies of fish, meat and wild meat consumption were converted to ordered factors. Variables' independence was tested with Chi-square tests. All analyses were run in R (R Core Team, 2020) using the package MASS (Venables and Ripley, 2002).

Results

Typology of vendors

In total, we identified 83 vendors. The 72 vendors willing to participate in the surveys were distributed across six regions in 29 locations on the coast: seven market vendors, 13 meat shops, 14 restaurants, 17 rum shops, 18 home-based traders and three roadside traders. We categorized vendors into two types: raw meat vendors and cooked meat vendors, with raw meat vendors including market vendors, home-based traders, and roadside traders; and cooked meat vendors including

restaurants, food stalls and rum shops. Below we provide a description of each vendor typology.

- Market vendors sell raw meat in stalls or from the back of their pickup truck or van. Markets operate on weekends only (except Charity Market, which operates on Mondays). These vendors sell either whole animals or specific parts, depending on the species, and they are willing to butcher the carcass according to the client's needs.
- Home-based traders store large amounts of raw wild meat in their freezers at home and they sell it to known clients in the neighbourhood, who call them or come by when they need wild meat. "*In this business, we don't need to know anyone, but people need to know us,*" said a home-based trader.
- Roadside traders often specialize in iguana trade but may sell other common species (such as agouti) depending on availability. Iguanas are sold alive to passing clients.
- Restaurants (high-end restaurants or speciality restaurants) and food stalls (roadside places serving mostly travelers or market-based food stalls) serve wild meat on their menus. Wild meat is most often prepared with curry (e.g. curry labba) or stewed with cassareep, a sauce made from cassava root.
- Rum shops are bars, where groups of friends (mostly men) gather after work or on weekends and share drinks and cutters (small pieces of fried meat served as finger food), often including wild meat.

In addition to the physical sale points, we also identified an online trading system via WhatsApp and social media (mostly Facebook). We did not attempt to systematically quantify the posts on social media but observed that they concerned opportunistic sales of raw or cooked meat, particularly during the month of September, which is Amerindian Heritage month in Guyana. Some of the established restaurants and home vendors also promote their products on Facebook.

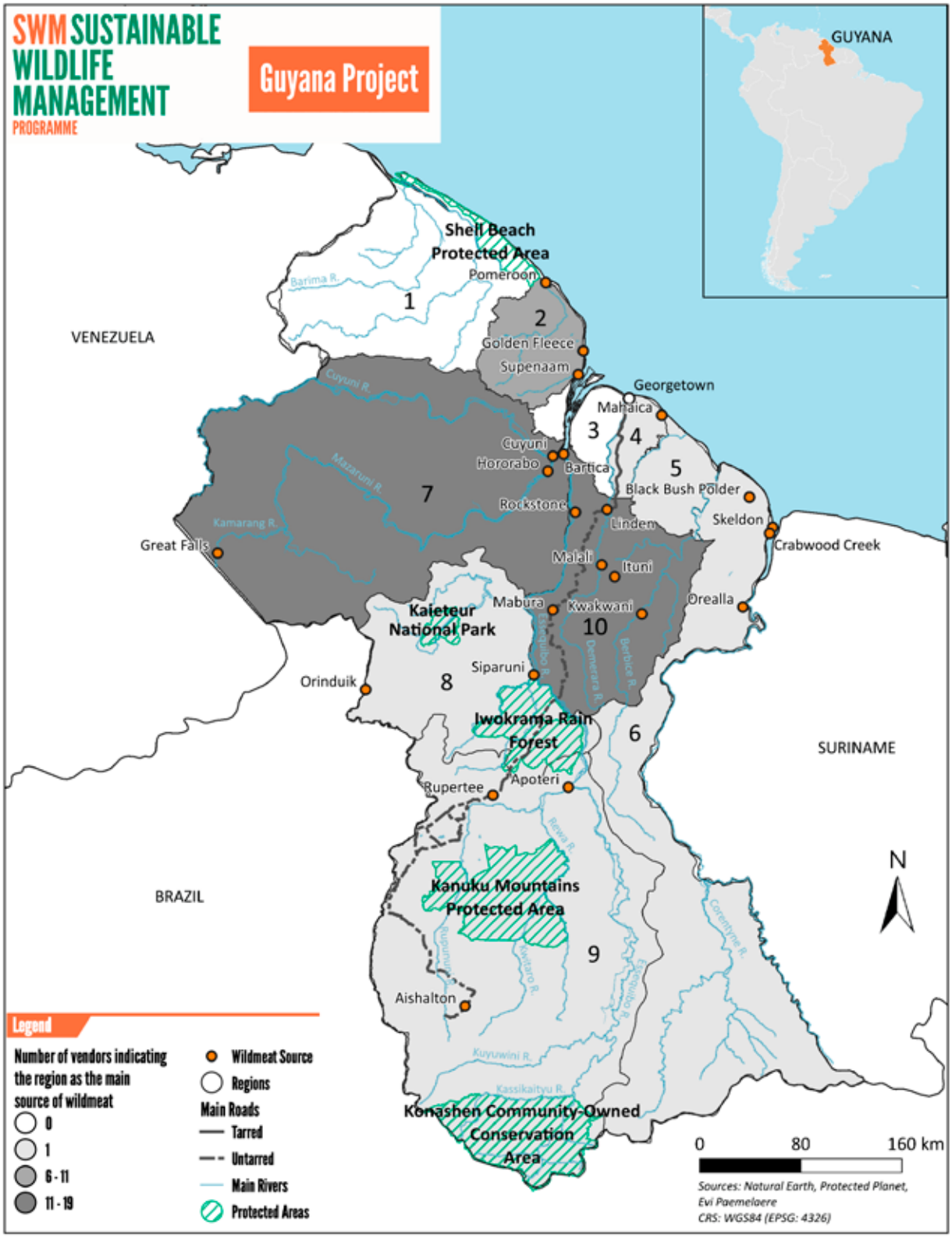
Out of all vendors interviewed, the majority were Indo-Guyanese (48 percent), followed by Amerindians (19 percent), Afro-Guyanese (16 percent), and those of mixed origins (16 percent). The business was dominated by men (75 percent), yet, a quarter of vendors were women. The vast majority of the vendors (82 percent) sold other types of meat (chicken, mutton, beef, duck, etc.) as well as fish products in addition to wild meat. Only 16 percent of the vendors sold wild meat exclusively, and they often relied on this business as their primary source of household income. Other vendors had additional sources of income, such as running a grocery shop or a restaurant (35 percent), farming (16 percent) or other (33 percent) (e.g. fishermen, employees in private companies or craftsmen/women). The age range of the vendors was between 17 and 65 years old, and they had been in the business for one to 55 years (SD=10.8). The vendors were evenly distributed across different categories of years of experience showing that this is a dynamic system allowing for newcomers into the business. Most vendors had completed secondary education (56 percent), while the others had only completed primary school.

Trade routes to the coast

Wild meat was sourced from several areas located in the interior, but mostly from Region 7 and Region 10 (see Figure 32).

Most vendors (83 percent) mentioned that their wild meat is transported to the coast on vehicles or trucks. Other means of transportation are outboard boats (mentioned by 61 percent of vendors) and motorcycles (15 percent). Source areas for wild meat are generally located along the roads or rivers at about 50 km to 80 km from the low plain coastal line. The road from Georgetown to Lethem is paved until Linden, which makes it possible for coastal hunters to reach some of the hunting grounds in Regions 10 and 8 within three hours by vehicle. Logging and mining areas, like Kwakwani/Ituni and the larger Mabura area are important sources of wild meat (see Figure 33). These areas typically have access to generators for ice production, cartridges and transportation via trucks or outboard boats. Hunting grounds along main rivers (Berbice, Demerara, Essequibo, Pomeroon and Corentyne) are crucial sources of wild meat. The

Figure 32. Map indicating the major wild meat sources and transport routes between the interior and the coast of Guyana



The boundaries and names shown and the designations used on this/these map(s) do not imply the expression of any opinion whatsoever on the part of FAO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers and boundaries. Dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

meat is transported on outboard boats in coolers filled with ice to keep it cool for two to three days. The availability of ice limits the duration and distance of hunting trips, and hunters may need to find ice along the way to preserve the meat properly. Out of the 72 vendors on the coast, seven occasionally got wild meat from as far as Region 9, at the southern end of Guyana bordering Brazil. Wild meat from Region 9 travels to the coast on mining trucks coming from the Marudi mining area or is sourced from ranches or Indigenous land from North Rupununi. However, given the distance and conditions of the road from Linden to Lethem, this trade route is not established, but rather is opportunistic in nature. Some vendors mentioned that wild meat harvested in Guyana, particularly labba (*Cuniculus paca*) and agouti (*Dasyprocta leporine),* is occasionally exported to neighbouring countries, and seizures of such meat did occur during the study period. Existence of a closed hunting season in Suriname, a temporary ban on hunting in Trinidad and Tobago, and the illegal nature of hunting in Brazil may encourage this trade. However, according to the vendors' experiences, this only occurs opportunistically without any structured trade beyond the borders of Guyana.

Hunting methods, handling/butchering and volumes of wild meat sold

According to 74 percent of the vendors, guns are the primary means of obtaining wild meat, often used in conjunction with hunting dogs. Traps were mentioned by 19 percent of the vendors, and bows and arrows by seven percent (and only used by Indigenous hunters). Sixty-eight percent of vendors reported that wild meat is transported to the place of sale either gutted on ice or as fresh kill. Live transportation is limited to iguanas. Only ten percent of the raw meat vendors sold was frozen, smoked or salted. Freezing the meat was the most common form of preservation and stocking (77 percent), but some just kept it on ice (23 percent). Primary harvesters usually skin and eviscerate the game at the harvest site. Vendors butcher the meat (and cook, if in a restaurant), according to consumer preference. Sixteen percent of the sale points lack access to tapped water at their sale point and rely on river or rainfall water. Electricity is available at 83 percent of sale points,

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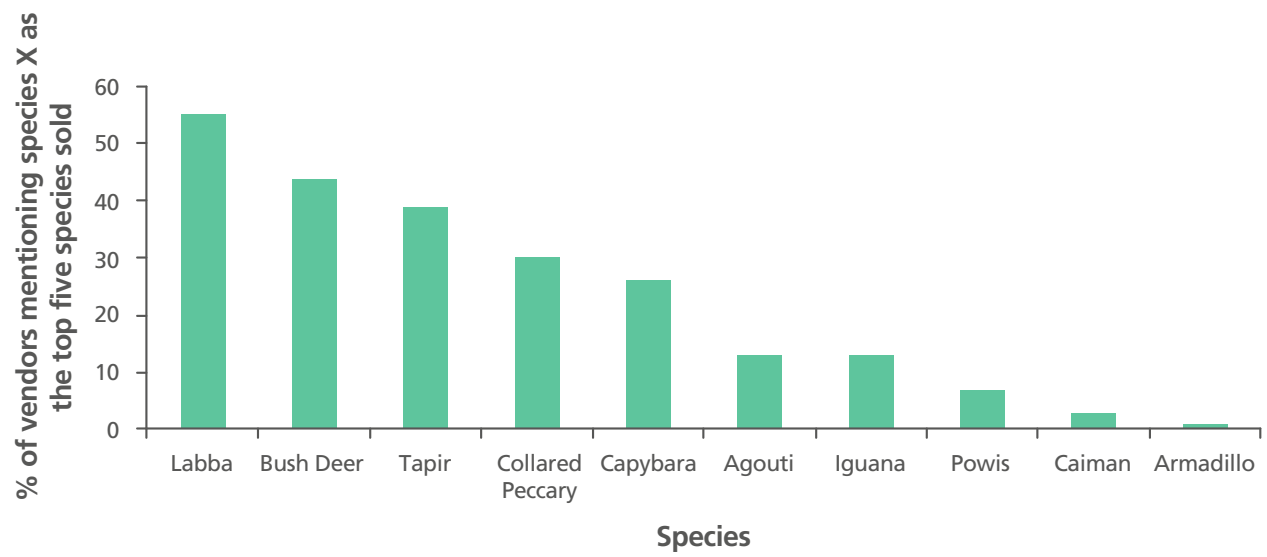
Wapichan hunter crossing a river

Figure 33. Relative importance of species sold on the coast



Source: van Vliet et al. 2023. CIFOR-ICRAF.

with ten percent using solar panels and the rest relying on the general electrical service. Although only five percent of coastal vendors reported losses of wild meat due to poor conservation methods, some have lost more than 50 percent of their product when ice melts during transportation. No special equipment is worn during the handling of wild meat, aside from an apron.

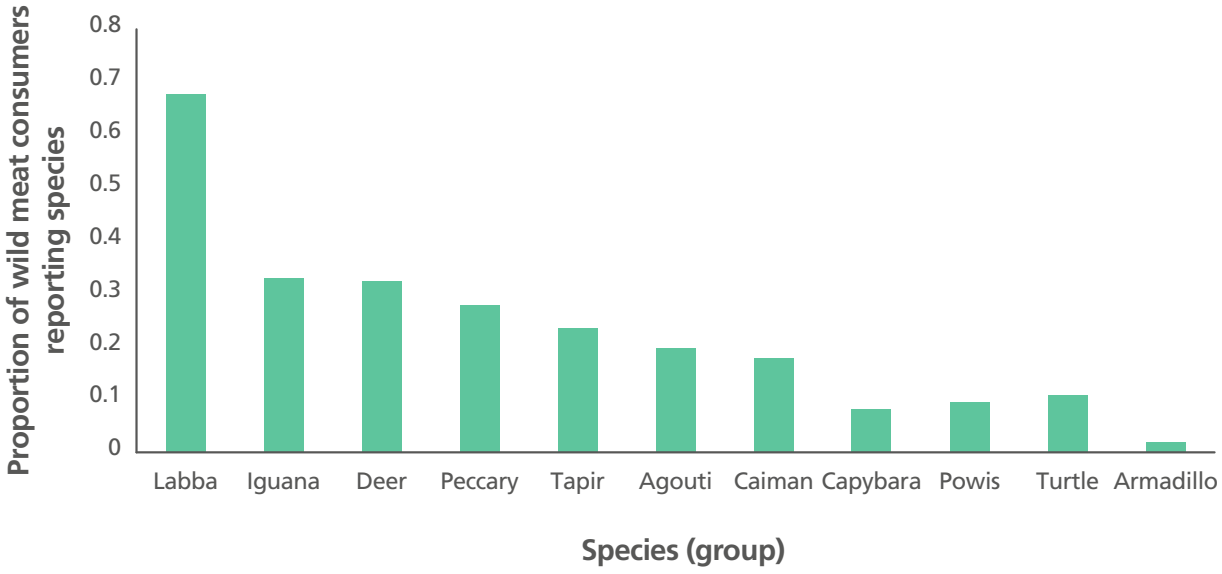
According to the vendors, sales of wild meat are stable throughout the year but slight peaks are observed in December (Christmas) and September (Amerindian Heritage month). Based on estimations made at the level of primary vendors (those that were either hunters themselves or purchased directly from hunters, thereby excluding vendors that purchased from other vendors), the amounts sold per day (kg/day) ranged between one and 150 kg/day with a mean of 14.9 kg/day. Based on those primary harvesters, and considering a steady trade all year (therefore excluding higher peaks in December and September), we estimate that about 361 080 kg of wild meat is sold per year on the coast. However, this is likely an underestimation as it does not account for personal consumption and non-commercial networks.

Of the 72 vendors surveyed, 55 reported difficulties in obtaining wild meat for their business. The primary harvesters also expressed concern over the lack of supply, with 80 percent of them citing it as their main challenge. This is primarily due to having to travel further to find enough wild meat, or not being able to obtain enough of the most popular species such as labba, deer, peccary and tapir.

Species traded and species consumed

The top five most sold species were labba (*Cuniculus paca*), bush deer (*Mazama americana*), tapir (*Tapirus terrestris*), peccary (*Dicotyles tajacu, Tayassu pecari*) and capybara (*Hydrochoerus hydrochaeris*) (see Figure 33). Other species commonly sold were agouti (*Dasyprocta leporina*), powis (*Crax alector*) caimans and armadillos (no identification of species was possible for these last two groups). The top five most consumed species were labba, deer (*Mazama* sp. *and Odocoileus* sp.), iguana (*Iguana iguana*), peccary and tapir (see Figure 34). Although tapir and white-lipped peccary are listed by the International Union for the Conservation of Nature (IUCN) as globally threatened, none of these species are protected in Guyana. Armadillos found in Guyana include giant armadillo (*Priodon-*

Figure 34. Relative importance of species among wild meat consumers; single mentions not included



Source: van Vliet et al. 2023. CIFOR-ICRAF.

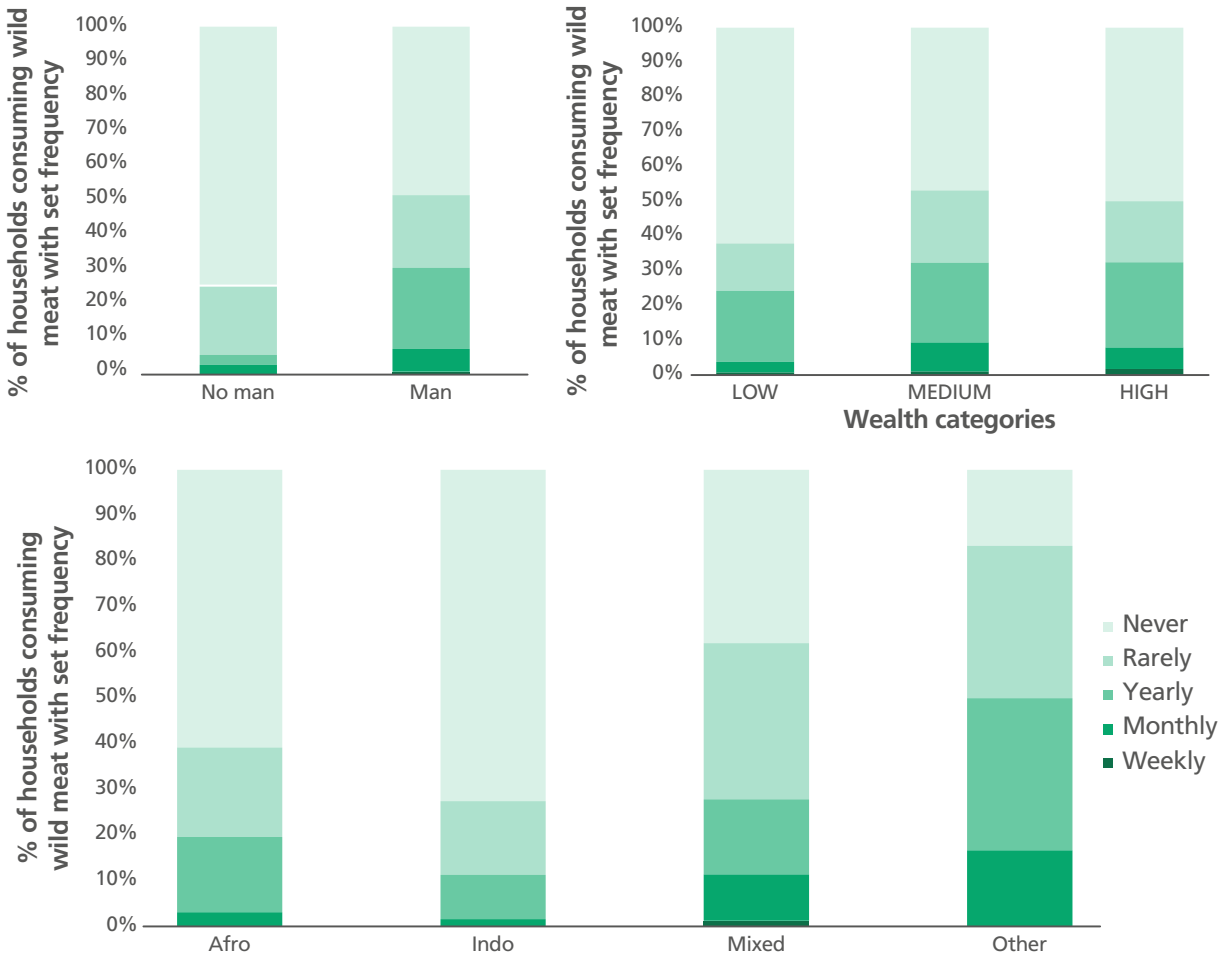
tes maximus), nine-banded armadillo (*Dasypus novemcinctus*), six-banded armadillo (*Eupharctus sexcinctus*) and southern naked-tailed armadillo (*Cabassous unicinctus*), of which the giant armadillo and southern naked-tailed armadillo are listed as vulnerable.

The importance of wild meat in the diet of urban consumers

Out of the 342 respondents surveyed, 46 percent reported consuming wild meat. However, the frequency of consumption was low, with only three percent eating it weekly and 12 percent consuming it once or twice a month. Almost half of the households had wild meat a few times a year (48.7 percent) or less than once a year (36.7 percent). The occasional consumers mostly received wild meat as a gift from family and friends, or at a meal with relatives and friends (69 percent). Conversely, frequent wild meat consumers (weekly or monthly) usually purchased it from a market vendor or hunter (61 percent). In contrast, domestic meat was consumed by nearly all respondents, with most eating it multiple times a week (52.9 percent) or even daily (32.8 percent). This included mostly chicken (97 percent), followed by beef (67 percent) and pork (44 percent). A few respondents mentioned consuming goat, turkey or duck. Fish was also eaten by most respondents, with nearly half consuming it at least three times a week (43.9 percent), while others once or twice a week (21.7 percent), or once or twice a month (23.8 percent).

The main reason for consuming wild meat was its taste, as reported by most consumers. For some, it also represented the traditional meal, while for others it provided an exotic option to add variety to their diet. People also consumed it because it is a free source of meat (e.g. self-hunted or gift) or because it is considered healthy. The reasons for not consuming wild meat included disliking its taste, religious beliefs, and unavailability of the meat. Frequency of wild meat consumption was significantly higher among Indigenous households or households of mixed descent compared to Indo-Guyanese and Afro-Guyanese households (Pmixed = 0.0051; Pother = 0.011) (see Figure 35). Having at least one man in the household and having a hunter in the household were also associated with higher consumption frequency of wild meat (P_{MenHH}= 0.0081), as was being of a higher wealth class (P_{Wealth}= 0.0498).

Figure 35. Results of the ordinal logistic regression*



Source: van Vliet et al. 2023. CIFOR-ICRAF.

**Results of the ordinal logistic regression showed that the presence of men in the household, ethnicity and wealth categories were significantly associated with frequency of wild meat consumption.*

Discussion

This study sheds light on the wild meat trade and consumption practices on the coast of Guyana, contributing to a better understanding of the wild meat sector in the Caribbean, an understudied region in terms of this topic (Ingram *et al.*, 2021), and to a better assessment of the implications of the trade for wildlife management in the Rupununi region.

Our study shows that the market chain on the coast of Guyana is short and direct, with harvesters selling directly to consumers. According to the typology by Phelps (2016), the primary harvester in Guyana is a "specialized commercial harvester", which requires sophisticated technologies for meat preservation and hunting, as well as networks and coordination to harvest. In this context, where demand outstrips supply, and trade is legal (or unregulated at the time of the study), finding consumers is not a challenge. The main limiting factor for urban hunters to enter the wild meat trade business is access to hunting grounds. External hunters often require strong networks with communities to gain access to the resource, and count on acquaintances as guides. On Indigenous community lands, outsiders are generally not allowed to hunt without prior permission from local traditional

authorities, unless they have become part of the community through a rights claim secured by family or friendship linkages with residents of the community (McDonald, 2016).

The majority of source areas for wild meat are located within 50 km to 80 km from the low plain coastal line, along the main access routes such as rivers and roads. This means that the trade in wildmeat currently puts pressure on accessible forest areas near the main consumption hubs and leaves remote forests relatively untouched from commercial use. Although the Rupununi region (Region 9) is only marginally involved as a source of wild meat for the coast, improved access through the Georgetown-Lethem road will likely increase access to hunting grounds in the Rupununi. Traveling further to hunt is becoming a major constraint, as reported by the primary harvesters we interviewed. This suggests that wildlife populations may be declining in accessible hunting grounds, increasing the attractiveness of more remote areas. Studies in rural areas of Guyana have linked wildlife decline to factors such as human population size (Iwamura, 2014), distance from villages (Hallett *et al*., 2019), and the increased use of shotguns (Shaffer *et al*., 2017). While current levels of hunting may be sustainable in remote communities, small shifts in activity patterns and distribution of some game species indicate possible over-harvesting, particularly for lowland tapir and the long-nosed armadillo (Shaffer *et al.*, 2017; Hallett *et al*., 2019).

As shown in other studies across tropical forest areas, the bulk of the wild meat volumes sold on the coast of Guyana mostly involves non-endangered species (labba, collared peccary, bush deer, iguana). While labba hunting may be unsustainable locally, the species is of least concern globally and can withstand current harvest rates (Emmons, 2016), likely due to its high reproduction rate and ability to maintain viable populations within small areas (Benchimol and Venticinque, 2014). On the other hand, tapir hunting, which is legal in Guyana to allow subsistence use by Indigenous communities, should be prohibited for trade as the species is globally threatened and more vulnerable to hunting pressure due to its larger size and associated resource needs and slow growth rate (Varela *et al.*, 2019).

In coastal Guyana, wild meat is considered a luxury, with higher prices compared to other meat sources and demand increasing for special events like Christmas and heritage, as well as at weekends (see Table 22). This trend is observed in other large cities worldwide where wild meat is associated with cultural identity and social events (Wilkie *et al.*, 2016; Chausson *et al.,* 2019). For example, in

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An iguana seen on a riverbank

the Colombian Amazon, despite increased access to cheap chicken and processed foods, demand for wild meat remains high as an occasional cultural meal due to taste and tradition (Morsello *et al*., 2015).

Table 22. Mean prices of wild meat (top five most sold species) and domestic meat on the coast of Guyana

	Species	Mean price for final customer (USD/kg)
Wild meat	Bush deer	4.25
	Labba	3.5
	Capybara	3.25
	Collared peccary	4
	Tapir	4
Domestic	Beef	2.4
	Chicken	1.65
	Pork	1.65
	Mutton	5

Source: van Vliet et al. 2023. CIFOR-ICRAF.

Guyanese cuisine is renowned for its unique and distinct flavours, and it is regarded as a symbol of cultural identity. Wild meat is used in several speciality dishes, such as pepperpot and curry meats (Richards-Greaves, 2013). Pepperpot, an Indigenous speciality dish particularly consumed for Christmas, is a thick, dark brown, stew-like dish that is made with various types of meat (including wild meat) and boiled in cassava-based cassareep with various spices. Curries can be prepared with all sorts of meats, but "curry labba" is probably the most renowned, consumed in high-end restaurants or in rum bars as finger food. Ethnicity was found to be the key determinant in wild meat consumption, with Indigenous households and those of mixed origin consuming it more frequently.

The volume of wild meat traded to the coast of Guyana annually is estimated to be around 361 tonnes. This translates to a per capita consumption of 0.5 kg per year or 1.4 g per day. In comparison to urban towns in the central Amazonian region of Brazil, where wild meat consumption can be as high as 18 g per capita per day (El Bizri *et al*., 2020), wild meat consumption in Guyana

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Wild meat being prepared for customers in a Georgetown restaurant

seems to be limited. This could be due to religious affiliations – for example, the Muslim community, which accounts for 7.3 percent of the population, only consumes halal meat; Hindus (24.8 percent of the population) are generally vegetarian; and Seventh-day Adventists (eight percent of the population) do not eat pork or the wild cousin, peccary (Richards-Greaves, 2013). According to FAOSTAT data from 2018, animal protein intake in Guyana is estimated to be 35.3 g per day per capita, with wild meat contributing to less than four percent of the animal protein intake in coastal regions. However, as extractive activities promote the growth of medium-sized towns in the interior, there is a potential for significant growth of the wild meat trade over the coming decades.

Our study reveals that there is a high demand for wild meat in urban areas of Guyana. The trade mostly focuses on rapidly reproducing species, but it also includes sensitive species such as white-lipped peccary, armadillos and tapirs. To ensure the sustainable use of these species, it is crucial to monitor the trade carefully and enforce regulations. The GWCMC is working towards developing and enforcing regulations that will include a licensing system for commercial hunting and trade, hunting seasons and a quota system. While regulations and enforcement can contribute to the sustainable use of wild meat, behaviour change campaigns, such as those developed by Chavez *et al.* (2019) in Brazil, may help curb the demand for vulnerable species like tapirs and armadillos. In parallel, processes that strengthen local governance systems and encourage co-management models (for example, through the titling of Indigenous lands) may help maintain customary access rules and avoid open access scenarios. This will be particularly relevant in view of the upgrading of roads that will provide better access to remote areas in the interior of the country. From a One Health perspective, it is also essential to focus on food safety aspects along the legal trade chain.

References

Benchimol, M. & Venticinque, E.M. 2014. Responses of primates to landscape change in Amazonian land-bridge islands – a multi-scale analysis. *Biotropica*, 46: 470–478.

Carignano Torres, P., Morsello, C., Parry, L. & Pardini, R. 2021. Forest cover and social relations are more important than economic factors in driving hunting and bushmeat consumption in post-frontier Amazonia. *Biological Conservation*, 253: 108823.

Carignano Torres, P., Morsello, C. & Parry, L. 2022. Rural–urban mobility influences wildmeat access and consumption in the Brazilian Amazon. *Oryx*, 56: 1–13.

Chausson, A.M., Rowcliffe, J.M., Escouflaire, L., Wieland, M. & Wright, J.H. 2019. Understanding the sociocultural drivers of urban bushmeat consumption for behavior change interventions in Pointe Noire, Republic of Congo. *Human Ecology*, 47: 179–191. Springer US.

de Araujo Lima Constantino, P., Valente-Neto, F., Nunes, A.V. & Campos-Silva, J.V. 2021. Culture still matters: conservation implications of hunting by ethnolinguistic groups in Southwestern Amazonia after centuries of contact. *Biodiversity and Conservation*, 30: 445–460. Springer Netherlands.

El Bizri, H.R., Morcatty, T.Q., Valsecchi, J., Mayor, P., Ribeiro, J.E.S., Vasconcelos Neto, C.F.A. *et al*. 2020. Urban wild meat consumption and trade in central Amazonia. *Conservation Biology*, 34: 438–448.

Emmons, L.H. 2016. *Cuniculus paca*. In: *The red list of threatened species 2016* p. e.T699A22197347. Also available at: https://doi.org/10.2305/IUCN.UK.2016-2.RLTS.T699A22197347.en.

Gibson, L. 2020. Bycatch of the Day: Wild Meat Consumption, Ecological Knowledge, and Symbolic Capital among Indigenous Maroon Parrot Hunters of Jamaica. *Journal of Ethnobiology*, 40: 167–182.

Hallett, M.T., Kinahan, A.A., McGregor, R., Baggallay, T., Babb, T., Barnabus, H. *et al*. 2019. Impact of low-intensity hunting on game species in and around the Kanuku Mountains Protected Area, Guyana. *Frontiers in Ecology and Evolution*, 7(412). https://doi.org/10.3389/fevo.2019.00412

Ingram, D.J., Coad, L., Milner-Gulland, E.J., Parry, L., Wilkie, D., Bakarr, M. I. *et al.* 2021. Wild meat is still on the menu: Progress in wild meat research, policy, and practice from 2002 to 2020. *Annual Review of Environment and Resources*, 46: 221–254.

Iwamura, T., Lambin, E.F., Silvius, K.M., Luzar, J.B. & Fragoso, J.M. 2014. Agent-based modeling of hunting and subsistence agriculture on indigenous lands: understanding interactions between social and ecological systems. *Environmental Modelling & Software*, 58: 109–127.

Jones, C.B. & Young, J. 2004. Hunting restraint by Creoles at the Community Baboon Sanctuary, Belize: a preliminary survey. *Journal of Applied Animal Welfare Science*, 7: 127–141.

MacDonald, K. 2016 "No trespassing": changing and contested rights to land in the Guyanese Amazon. *Journal of Latin American Geography* 59–82.

Morsello, C., Yagüe B., Beltreschi, L., van Vliet, N., Adams, C., Schor, T. *et al*. 2015. Cultural attitudes are stronger predictors of bushmeat consumption and preference than economic factors among urban Amazonians from Brazil and Colombia. *Ecology and Society*, 20.

Nasi, R., Taber, A. & van Vliet, N. 2011. Empty forests, empty stomachs? Bushmeat and livelihoods in the Congo and Amazon Basins. *International Forestry Review*, 13: 355–368.

Nicholson, D.J., Kanagavel, A., Baron, J., Durand, S., Murray, C. & Tapley, B. 2020. Cultural association and its role in garnering support for conservation: the case of the Mountain Chicken Frog on Dominica. *Amphibian and Reptile Conservation*, 14:133–144.

Pacheco-Cobos, L. & Winterhalder, B. 2021. Ethnographic Observations on the Role of Domestic Dogs in the Lowland Tropics of Belize with Emphasis on Crop Protection and Subsistence Hunting. *Human Ecology*, 49: 779–794. Springer US.

Peñaloza, C.L., Hernández, O., Espín, R., Crowder, L.B. & Barreto, G.R. 2013. Harvest of Endangered Sideneck River Turtles (*Podocnemis* spp.) in the Middle Orinoco, Venezuela. *Copeia*: 111–120.

Phelps, J., Biggs, D. & Webb, E.L. 2016. Tools and terms for understanding illegal wildlife trade. *Frontiers in Ecology and the Environment,* 14(9): 479–489.

R Core Team 2020. R: *A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria.

Richards-Greaves, G. 2013. The intersections of 'Guyanese food' and construction of gender, race and nationhood. In: *Food and Identity in the Caribbean,* ed. H. Garth. 75–94. Bloomsbury.

Rushton, J., Viscarra, R., Viscarra, C., Basset, F., Baptista, R. & Brown, D. 2005. How Important is Bushmeat Consumption in South America: Now and in the Future? *Odi Wildlife Policy Briefing*, 11:1–4.

Shaffer, C.A., Milstein, M.S. Yukuma, C., Marawanaru, E. & Suse, P. 2017. Sustainability and co-management of subsistence hunting in an indigenous reserve in Guyana. *Conservation Biology*, 31(5):1119–1131.

van Vliet, N., Antunes, A.P. Constantino, P. de A.L., Gómez J., Santos-Fita, D. & Sartoretto, E. 2019. Frameworks regulating hunting for meat in tropical countries leave the sector in the Limbo. *Frontiers in Ecology and Evolution*, 7.

van Vliet, N., Puran, A., David, O. & Nasi, R. 2022. From the forest to the coast: the wild meat trade chain on the Coast of Guyana. *Ethnobiology and Conservation*, 11.

van Vliet, N., Quiceno Mesa, M.P., Cruz-Antia, D., Neves de Aquino, L.J, Moreno, J. & Nasi, R. 2014. The uncovered volumes of bushmeat commercialized in the Amazonian trifrontier between Colombia, Peru & Brazil. *Ethnobiology and Conservation*, 3:1–11. https://doi.org/10.15451/ec2014-11-3.7-1-11

Varela, D., Flesher, K., Cartes, J.L. de Bustos, S., Chalukian, S., Ayala, G. & Richard-Hansen, C. 2019. *Tapirus terrestris*. *The IUCN Red List of Threatened Species 2019*. http://dx.doi.org/10.2305/IUCN.UK.2019-1.RLTS.T21474A45174127.en. (Accessed 29 August 2019).

Venables, W. & Ripley, B. 2002. *Modern Applied Statistics with S*. Springer, New York.

Wilkie, D.S., Wieland, M., Boulet, H., Le Bel, S., van Vliet, N., Cornelis, D. *et al*. 2016. Eating and conserving bushmeat in Africa. *African Journal of Ecology*, 54:402–414.

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Local hunter, Alan Mandook, waits high in a tree for passing wildlife

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Consultations for the development of the fisheries co-management plan and regulations

4. Wildlife management and conservation initiatives in the Rupununi

4.1. Co-management of inland fisheries in the North Rupununi Wetlands

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Highlights

- North Rupununi communities in Guyana, under the leadership of the North Rupununi District Development Board (NRDDB), initiated a series of conservation measures to ensure sustainable use of fish resources. Conservation measures led to the development of a management plan for arapaima in 2002 and a co-management plan for fisheries in the North Rupununi in 2011.
- Both plans faced implementation challenges due to a lack of national legislation and support from government agencies.
- To address these problems, a series of stakeholder consultations was carried out from the 19 to the 24 August 2022, providing a forum for local fishers and community representatives to express their needs and identify challenges, which led to an updated version of the Co-management Plan for Fisheries in the North Rupununi Wetlands 2023.
- The new 2023 co-management plan has two goals:
  - the sustainable management of fish resources using traditional knowledge supported by science; and
  - to serve as a model for the development of similar co-management plans in other regions.
- The plan is based on sharing responsibilities for fisheries management between communities and government agencies, with clear boundaries for subsistence, small-scale, commercial and sport fishing activities, and a local governance structure that assigns fishing-ground rights to communities.
- The plan requires an adaptive management approach and will be implemented by the North Rupununi Wetlands Co-management Committee with ground support from the various community fishery committees.

Introduction

For inland communities in Guyana, fishing is an important subsistence and economic activity, providing food for consumption and cash income for local people (Chapter 2.3). Compared to the Amazon, and except for arapaima, fish populations in the North Rupununi Wetlands show moderate levels of exploitation (i.e., most fish stocks are not yet strongly overfished). Nonetheless, some areas are experiencing the loss of larger individuals, consistent with size-selective exploitation due to unmanaged and unregulated fishing activities (Shephard *et al.* 2022).

In particular, arapaima (*Arapaima* spp.) has experienced intense exploitation due to unregulated commercial harvesting that began in the 1970s. That exploitation continued to the point that by 2001, the arapaima fishery had collapsed with only about 820 individuals longer than 1 m remaining in the Upper Essequibo Basin.

As a conservation measure, communities in the North Rupununi, under the leadership of the North Rupununi District Development Board (NRDDB), imposed a self-ban on the harvesting of arapaima, and developed the first version of the Arapaima Management Plan (AMP) in 2002. Nine years later, the communities came together again to address the need to manage their fish resources, and to avoid the same fate they faced with arapaima. As a result, the Co-management Plan for Fisheries in the North Rupununi Wetlands 2011 was developed. Both plans offer a series of guidelines for communities to ensure their fish resources are used sustainably, thereby safeguarding their food security and income in the short and long term. In addition to subsistence fishing, the plan also includes other community-based fishery-dependent economic activities such as commercial, sport, aquaculture and aquarium fisheries.

The AMP 2002 and the 2011 co-management plan for fisheries were never fully implemented, due to several concerns cited by local communities. In 2019, with support from the SWM Programme, the NRDDB generated a baseline of the fisheries sector and the first general fish stock assessments. It also implemented awareness raising through local radio, and organized meetings at the community level to gather feedback on the fisheries management plan from community members (see Chapter 1.3). In 2022, it became obvious the co-management plan of 2011 required revision to reflect current needs and realities of the communities. To update and revise the plans, a series of stakeholder consultations were carried out from the 19–24 August 2022 with the participation of local fishers and community representatives from 15 communities in the North Rupununi, representatives of the SWM Programme, the Fisheries Department of the Ministry of Agriculture and members of NRDDB.

The consultations provided a forum for fishers and other community representatives to express their needs concerning the management of their fish resources, identify elements in the initial versions of the plans that proved difficult to implement, and provide suggestions for modifications of the plans that will allow for effective implementation. Communities, for example, identified the following as the most relevant issues precluding full implementation of both plans: 1) lack of national legislations for inland fisheries to support local regulations; 2) lack of power to control entry by non-residents into communities' fishing grounds and to enforce local regulations; 3) lack of support from government agencies/law enforcement officers to enforce local fishing regulations; 4) insufficient funds to monitor and assess fish stocks as well as patrol fishing grounds; and 5) burdensome permitting processes for subsistence fisheries.

The Government of Guyana recognized the need for legislation for inland fisheries, and with the support of the Food and Agriculture Organization of the United Nations (FAO) and the SWM Programme, prepared a draft Fisheries (Amendment) Bill to amend the Fisheries Act 2002. The amendments encompass the clear inclusion of inland fisheries and co-management arrangements for all fisheries waters in Guyana, and address the legal framework that can support fisheries co-management efforts by local communities. The management plan represents a co-management process that brings together communities and governments to share responsibility for managing the resources that are found in the waters and forests within a specific area.

In this chapter, we present the updated and revised version of the Co-management Plan for Fisheries in the North Rupununi Wetlands 2023. The version reflects the proposed amendments to the Fisheries Act 2002, and incorporates all the observations made by fishers, community leaders and community members that participated during the 2022 stakeholder consultation, as well as the views of representatives from government agencies and non-governmental

organizations (NGOs) that were also consulted as part of the process. In addition, a revised and updated version of the AMP 2002 has been integrated as a special section within the Co-management Plan for Fisheries in the North Rupununi Wetlands 2023 without losing its practicality as a stand-alone document that can be adopted by other communities outside the North Rupununi region.

Goals and boundaries for the North Rupununi Wetlands fisheries co-management area

There are two goals of the Co-management Plan for Fisheries in the North Rupununi Wetlands 2023:

- to ensure that communities in the North Rupununi region can effectively and sustainably manage their fish resources using indigenous traditional knowledge supported by science; and
- to provide a model for the development of similar co-management plans in other regions that depend heavily on local fish resources.

The goals can be achieved with the participation and compromise of an organized community of resource users (fishers), representatives of the communities, and the Government of Guyana with support and assistance from other stakeholders, such as NGOs and academic and research institutions. The participation of all these stakeholders must contribute to a healthy partnership arrangement with shared responsibilities and authority for the management of fish populations.

The North Rupununi Wetlands co-management area (see Figure 36) is bounded by the following natural boundaries: on the Essequibo River from Coco Creek to the confluence of the Siparuni and Essequibo Rivers; on the Rupununi River from Tawa Creek to the confluence of the Rupununi and Essequibo Rivers; on the Rewa River from Nut Pool to the confluence of the Rewa and Rupununi Rivers; on Bat Creek from Lime Landing to the confluence of Bat Creek and the Rupununi River; on the Burro Burro River from Kaiwan Paru to the confluence of the Burro Burro and Siparuni Rivers. The importance of establishing this co-management area is to provide jurisdictional rights to the communities to manage all aquatic resources liv-

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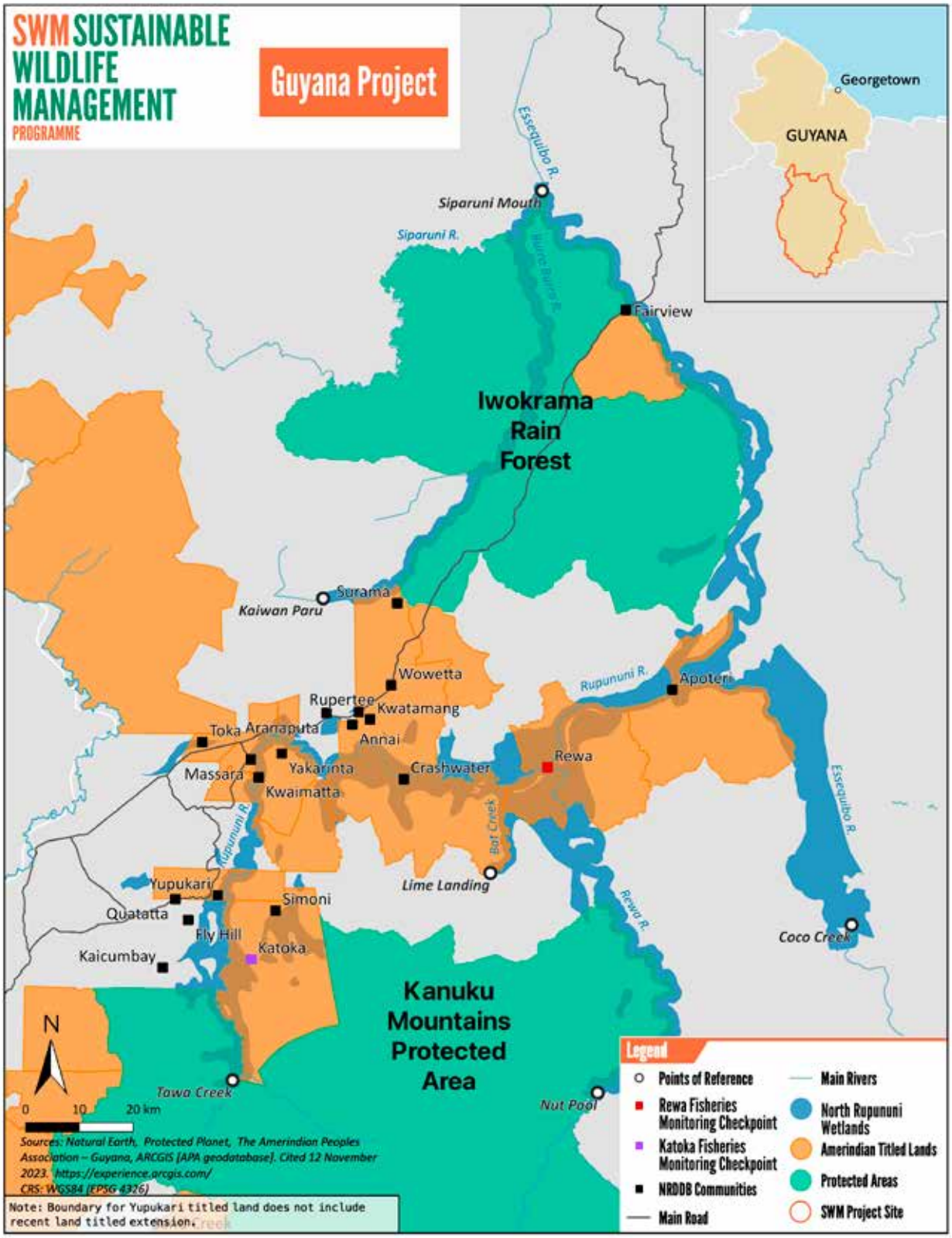
A fisher repairing his fishing line

Figure 36. Map of North Rupununi Wetlands Co-management Area



The boundaries and names shown and the designations used on this/these map(s) do not imply the expression of any opinion whatsoever on the part of FAO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers and boundaries. Dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

ing within the rivers, creeks, lakes and ponds within the above-mentioned boundaries. A defined co-management area gives communities the right to set out and enforce management guidelines for the use of resources found within this area. Legal provisions acknowledging the participant communities to act as co-managers are included in the proposed amendments to the Fisheries Act 2002.

Within the co-management area, the communities have identified the following locations where different levels/types of fishing should occur.

Subsistence fishing areas: These areas will cover nearby ponds, lakes and creeks, and the main rivers that are located close to the communities and will be used for daily subsistence fishing only. Within these designated areas, only traditional fishing methods should be used except during the rainy season when seines are allowed (see Table 23).

Small-scale fishing areas: These areas include fishing within the boundaries of the riverine communities, but not within the subsistence fishing areas. Small-scale fishers will need to be aware of the small-scale fishing areas to ensure that they are not fishing in subsistence fishing areas.

Commercial fishing areas: These areas will be beyond the boundaries of the riverine communities.

Sport fishing: Some communities have identified lakes and ponds for sport fishing within their fishing grounds/areas. These water bodies are listed as exempted from general fishing activities.

Local governance structure for the management of inland fisheries in the North Rupununi

A major component of effective natural resource management is the clear definition of resource tenure, access and use rights. Well-defined control over the fish resources of the North Rupununi is a prerequisite for communities to implement an effective management system. Hence, it is critical that the use and management rights of fishing grounds are assigned to the communities in North Rupununi.

The Government of Guyana recognizes the need for legislation for inland fisheries, and is working to amend the Fisheries Act 2002 to include inland fisheries and co-management arrangements for all fisheries waters. Legal co-management agreements between communities and the government will also be developed and subsequently executed. Co-management is defined by the National Policy on Inland Fisheries and Aquaculture in Guyana in the fisheries context as: "*the shared management of the aquatic resources between the government and user groups, shared regulatory decision-making among representatives of the user-groups, government agencies and research institutions, and management responsibility and authority delegated to the user groups.*"[3] Because the Co-management Plan for Fisheries in the North Rupununi Wetlands described here is based on sharing responsibilities for fisheries management between communities and government agencies, it is developed following a co-management approach as defined above.

The major assumptions of the co-management plan for fisheries are:

1. The communities can be successful resource managers if they:

   - have exclusive resource use rights;
   - have the legal support of national and local governments, which allows communities to act as stewards of their aquatic systems and resources; and
   - their actions and decision making are guided by a well-structured plan and traditional knowledge, as well as scientific advice.

2. The communities can establish conservative fishing quotas for species that may require recovery measures and that may lead to a gradual population increase.

3. Given the appropriate power, training and technical support, communities can conduct all the management activities that are required

[3] Ministry of Agriculture, Fisheries Department. 2012. National Policy on Inland Fisheries and Aquaculture in Guyana

for functioning of the plan.

4. The sustainability of the fisheries in the North Rupununi Wetlands will strengthen the long-term health of the aquatic system essential for effective fisheries management and biodiversity conservation.

In the co-management structure for inland fisheries in North Rupununi, communities decide how fish can be harvested, who can fish, what species can be caught, and how much fish is harvested yearly.

For this purpose, the Government of Guyana will provide communities with:

- exclusive user rights over the fish resources;
- legal support at the national and local levels of government so that communities can act as the stewards of the co-management area and the fish that live there; and
- authority, training and technical support so that communities can conduct all management activities that are required for the functioning of the plan.

Following the proposed amendments to the Fisheries Act 2002, the communities in the North Rupununi will need to establish a co-management committee as the main governance body for the co-management area. At the community level, the co-management committee will be supported by community fishery committees.

The co-management committee will be responsible for all fisheries management activities within the co-management area. The committee will be composed of 12 members and include elected representatives from communities that are a part of the North Rupununi Wetlands co-management area and can be fishers, community leaders, or any other community members representing the interests of their community. The co-management committee will also require at least one elected civil society representative (not a member of the participating communities), and one fisheries officer from the Fisheries Department. The Environmental Protection Agency (EPA) and the Guyana Wildlife Conservation and Management Commission can choose to nominate an observer for the meetings of the co-management committee. One member will be selected to serve as a secretary, and committee members are allowed to serve for a maximum period of ten years, or two consecutive periods of five years, with elections held every five years. It is recommended that the co-management committee has the same number of women and men as elected representatives.

Roles of the North Rupununi Wetlands Co-management Committee

1. The committee will be responsible for the effective management of the fisheries within the co-management area, and report to the Minister of Agriculture through the Chief Fisheries Officer.

- Within a year of establishment, the committee will adopt the fisheries co-management plans for the co-management area. In addition, the committee will develop a draft of the community by-laws representing the regulations under which communities will operate (e.g. enforcement, patrols, penalties, etc.).
- It will supervise and periodically review the implementation of the Co-management Plan for Fisheries in the North Rupununi Wetlands and the AMP.
- It will organize all data collection, consultation and awareness projects, and activities in connection with the preparation and implementation of the co-management plan.
- It will organize and oversee fisheries inspection and enforcement activities by community fisheries officers within the co-management area.
- It will liaise and interact with the Chief Fisheries Officer and other public agencies responsible for activities relating to, or which may affect, fisheries in the co-management area.

2. The co-management committee will submit a quarterly report and an annual report on its activities or as otherwise stated in the co-management arrangements, to the Chief Fisheries Officer. A co-management arrangement is a legally binding agreement between the Govern-

ment of Guyana and local communities that establishes shared responsibility for resource management, conservation and/or economic development. The committee shall also provide data and information upon request.

3. The co-management committee will be responsible for providing to the Chief Fisheries Officer information or explanations concerning the manner in which it fulfils its tasks.

   If the co-management committee does not fulfil its mandate correctly, or acts in any other manner that is contrary to the objectives and principles of the Fisheries Act, the ministry, on the advice of the Chief Fisheries Officer, may temporarily suspend or permanently abolish the committee.

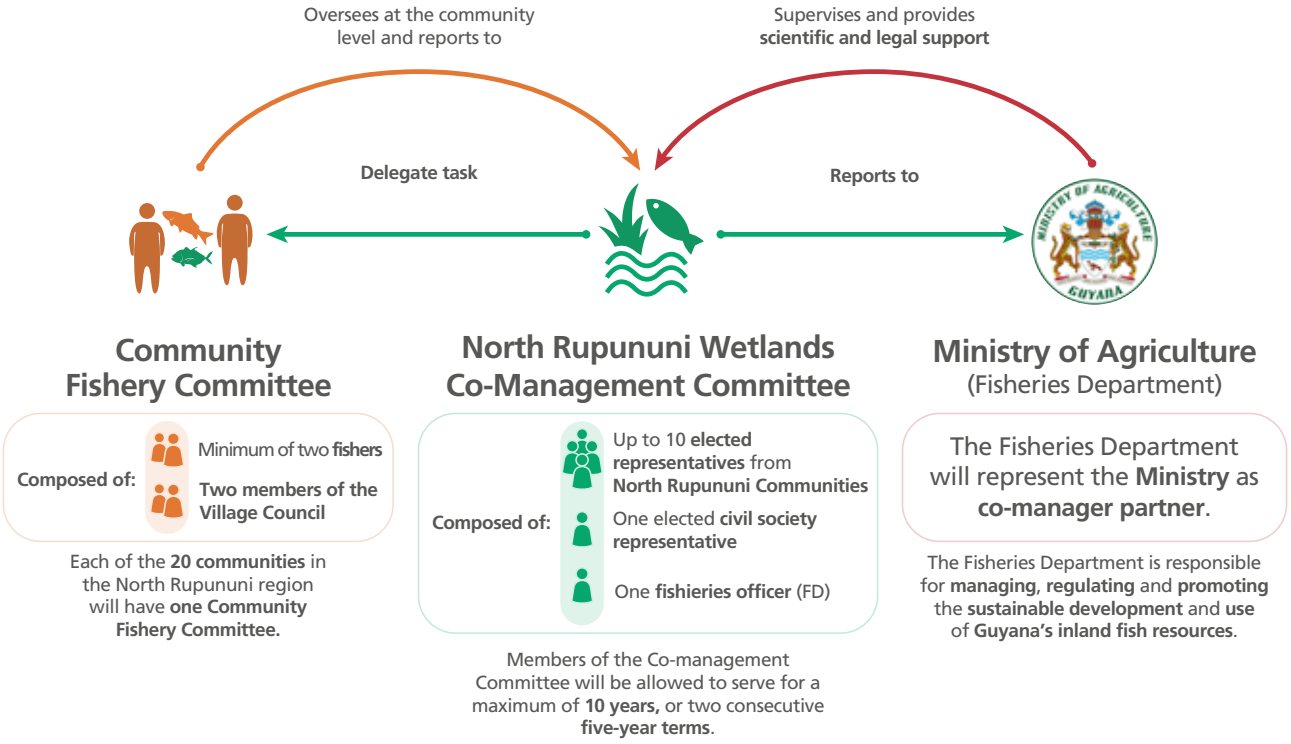
Community fishery committees will be established in each community to represent the interests of its fishers and to support the co-management committee. Each community fishery committee will be formed by at least two resident fishers/persons elected by the community and the village leaders and two members of the village council. A resident is defined as a fisher/person who spends more than six months living in the community that he/she will represent.

The community fishery committees will be responsible for enforcing the rules and organizing the fishery according to the responsibilities delegated by the co-management committee. These local committees will respond to the co-management committee and will prepare reports related to the violation of rules, and area encroachment, and maintain data related to fish extraction at the commercial level. Finally, the community fishery committees will be responsible for organizing fishers that will participate in monitoring as required by the plan.

If it is suspected that a person has breached a by-law made by the co-management committee, that person may be required to explain their actions. The penalties for rule breakers will follow those outlined in the amended Fisheries Act 2002 [26E(3)], which states that any person who breach-

©FAO/David Mansell-Moullin
A fisher goes home with his fresh catch of lukunani

Figure 37. Governance structure for North Rupununi Wetlands co-management


Oversees at the community level and reports to
Supervises and provides scientific and legal support
Delegate task
Reports to
Community Fishery Committee
Composed of:
Minimum of two fishers
Two members of the Village Council
Each of the 20 communities in the North Rupununi region will have one Community Fishery Committee.
North Rupununi Wetlands Co-Management Committee
Composed of:
Up to 10 elected representatives from North Rupununi Communities
One elected civil society representative
One fishieries officer (FD)
Members of the Co-management Committee will be allowed to serve for a maximum of 10 years, or two consecutive five-year terms.
Ministry of Agriculture
(Fisheries Department)
The Fisheries Department will represent the Ministry as co-manager partner.
The Fisheries Department is responsible for managing, regulating and promoting the sustainable development and use of Guyana's inland fish resources.

Source: Watson et al. 2023. CIFOR-ICRAF.

es a co-management by-law commits an offence and shall be liable on summary conviction to a fine.

If it is alleged that any person has breached a by-law made by the co-management committee, that person may be required to appear before the committee (if the incident occurred outside of community territory, but within the co-management area); or the relevant community fishery committee of the area where the violation occurred. The individual will be required to present themselves at their own expense.

The co-management committee/community fishery committee shall inform the person of the allegation, investigate the matter and give the person a reasonable opportunity to be heard. The violator will be given three opportunities to appear before appropriate action will be taken in their absence.

If the co-management committee/community fishery committee is satisfied that the person has breached the by-laws, the co-management committee may exercise the full provisions of the amended Fisheries Act 2002.

The communities have agreed to the following:

- For the first offence, the offender will be given a verbal or written warning by the community fishery committee or co-management committee.
- For the second offence, the offender will be required to appear before the community fishery committee or co-management committee.
- For the third or subsequent offence, if the person has continued to break the rules, then the co-management committee will decide if it will exercise the full provisions of the amended Fisheries Act 2002.

Sustainable use of fish within the management area

As part of the inland fisheries management for communities in the North Rupununi, the following fishing activities for the co-management area are authorized:

- food fisheries (subsistence/customary/commercial);
- farming/aquaculture fisheries;
- aquarium fisheries; and
- sport fishing/recreational fisheries.

Food fisheries (subsistence/customary/commercial)

Requirements for each of the fishing activities (see Table 23) were developed by local communities and reviewed by government representatives. The most important points are the following:

- All community members are allowed to practise subsistence fishing as defined in the amended Fisheries Act as fishing for personal or family consumption, which includes the direct sale of excess catch at the local level to a final consumer, subject to any limits or restrictions set out in the co-management plan. No licence is required to do so.
- All community members/fishers wishing to practise commercial fishing must register with the co-management committee through the community fishery committee in their respective community.
- All community members/fishers wishing to practise small-scale and commercial fisheries can apply for a licence to the fisheries department through the co-management committee, which will specify the areas where fishing can be done within the co-management area, the season and the quota.
- A fisher cannot apply for multiple licences.

Special species that are either protected by law or that communities identified as needing additional management to recover their populations are as follows:

- Arapaima (*Arapaima* spp.)
- Arawana (*Osteoglossum bichirrosum*)
- Lukunani/peacock bass (*Cichla ocellaris*)
- Basha/silver croaker (*Plagioscion squamosissimus*)
- Haimara/aimara (*Hoplias macrophthalmus*)
- Short-headed culit/tiger catfish (*Pseudoplatystoma fasciatum*)
- Long-headed culit/tiger catfish (*Pseudoplatystoma tigrinum*)

These species are usually the target of subsistence, commercial and sport fishing activities. Communities will be able to discuss which species can be restricted or under what terms.

Farming/aquaculture

As communities work to ensure their food security, and are cognizant of the increased pressure placed on their wild fish stocks – from human population growth to increased access to fishing resources in the regio – aquaculture of local species offers an alternative to the exploitation of wild stocks.

The practice of fish farming or aquaculture re-

©FAO/Luke McKenna
Fish farming is a relatively new practice in the Rupununi

Table 23. Requirements for the practising of subsistence and commercial fisheries in the North Rupununi Wetlands fisheries co-management area*

	Subsistence fisheries	Small-scale fisheries	Commercial fisheries
Licence	**no**	**no**	**yes**
Duration	Year-around	Open fishing season only	Open fishing season only
Issued by	-	Co-management committee	Fisheries Department
Cost	-	set by co-management committee in consultation with the Fisheries Department	Set by co-management committee in consultation with the Fisheries Department
Quota (adjustments must be communicated to Fisheries Department for approval)	**yes**	**yes**	**yes**
Frequency	Daily	Three trips per open fishing season for the calendar year	Three trips per open fishing season for the calendar year
Limit	No more than 25 lbs per household	25 to 300 lbs per fishing trip	300 – 1 200 lbs per fishing trip
Limitations	-	Small-scale fishers cannot apply for commercial fisheries licence.	Commercial fishers cannot apply for small-scale fisheries permit. Only 60% of the catch can contain lukanani, basha, haimara, culit and arawana. No by-catch allowed. All fish that are captured, and if alive and not wanted shall be released. If the fish has died during fishing it will be counted as part of the fishing quota.
Fishing Season	no	yes	yes
Open	-	1 September – 14 April	1 September – 14 April
Close	-	15 April – 31 August	15 April – 31 August
Fishing gear	Seines shall not be used during spawning and dry season.	Fishing methods allowed are seines with a five-inch eye, hook, line, cadel and bow and arrow. Cadels are not allowed in ponds and lakes as they may capture arapaima.	Fishing methods allowed are seines with a five-inch eye, hook, line, cadel and bow and arrow. Cadels are not allowed in ponds and lakes as they may capture arapaima.
Criteria for implementation	Definition of subsistence fisheries areas that will not interfere with fisheries conservation measures in place and implemented by the villages	Definition of small-scale and commercial fisheries areas that will not interfere with fisheries conservation measures in place and implemented by villages	Definition of small-scale and commercial fisheries areas that will not interfere with fisheries conservation measures in place and implemented by villages

Source: L. Cynthia Watson. 2023. Guyana.

**However, final decisions are taken by the Chief Fisheries Officer and Ministry of Agriculture in consultation with the co-management committee.*

quires a licence issued by the Fisheries Department. Fish farming must be done only with species that are native to the Rupununi Wetlands. Fish farming should be established as a well-organized activity where community members have the ability and have received training to perform all farm-related activities necessary for proper functioning. If fish farming is done to supply additional food to the communities, then everyone can share the responsibilities (e.g. feeding fish, general care and maintenance of farm facilities, etc.). If the fish will provide a way for communities to expand their income through the sale of fresh fish and other fish products, such as salted or smoked fish, the income can be used to pay wages, run farm operations, and develop/enhance community-based projects.

Aquarium fisheries

Communities can catch fish that will be sold for the aquarium trade. It represents another source of income for communities and follows the definition of ornamental fishes as stated in the updated Fisheries Act 2002. Aquarium fisheries, when well implemented and managed, can ensure the sustainability of the activity. This type of fishery requires the use of suitable harvesting methods, holding facilities, access to good markets, and training and involvement of community members.

The amendments to the Fisheries Act 2002 stipulate that fishing for ornamental fish requires a valid licence. An application for an ornamental fishing licence can be submitted to the co-management committee, which will make recommendations to the Fisheries Department. The licence should specify the locations in which ornamental fishing may be undertaken, the type of fishing gear that may be used, and the period for the licence.

Sport fishing/recreational fisheries

Sport fishing is a fairly new activity being offered as part of the eco tourism experience in the North Rupununi Wetlands. Guyana's many majestic rivers offer fishers the opportunity to catch many species that are similar to those found in the Amazon Basin. Some communities and independent tour operators in the North Rupununi have been working to develop sport fishing as an exciting and unique experience when visiting the region.

Based on the proposed amendments to the Fisheries Act 2002, any person wishing to serve as a sport fishing guide will need a licence issued by the Fisheries Department with recommendation from the co-management committee. Likewise, all sport fishers will require a licence issued by the Fisheries Department following a recommendation from the co-management committee before they can engage in any sport fishing within the co-management area. The co-management committee will need to keep a register of fishing guides. The register will be forwarded to the Chief Fisheries Officer as specified in the updated version of the Fisheries Act 2002.

Special focus on arapaima

Commercial harvesting of arapaima in the Rupununi began in the 1970s, which led to a near-crash in the population by 2001. Stock surveys were conducted ten times within the last 22 years and showed a steady increase until 2011, when the population was seven times larger than it was in 2001. However, in 2013 there was a 21 percent decrease in the population size from 2011. The latest population assessment conducted in late 2021 indicated a nine-fold increase in overall abundance compared to 2001, with 7 422 individuals recorded, of which 4 118 were juveniles (1.0 m to 1.5 m Total Length.) and 3 304 were adults (greater than 1.5 m Total Length.). The recovery is a clear indication that stricter regulations and conservation efforts adopted by communities were effective in curbing population declines. Despite the overall recovery, there is still widespread fishing of arapaima, especially in areas that are easily accessible by road (i.e. some areas on the Lower and Upper Rupununi) and of juveniles. This means that arapaima are still at risk, and communities must keep protecting and managing arapaima so that all communities in North Rupununi can benefit.

Fishers wishing to fish arapaima must be registered. A registration form is provided in the Arapaima Management Plan (AMP). The measures consist of six steps:

- **counting:** the number of arapaima must be counted in all lakes at the beginning of every dry season;
- **monitoring:** the count data for all the lakes will be added up and compared to the count data and harvest information from previous years; this will show if the population is growing, is the same, or is decreasing;
- **fishing quota determination:** based on the count and monitoring information, the number of individuals to be harvested will be determined;
- **fishing quota sharing:** the individuals to be harvested will be shared among the arapaima fishers;
- **fishing:** arapaima will be harvested based on three management restrictions:
  - only adult individuals are harvested;
  - adult individuals are harvested only when they are not reproducing; and
  - number of individuals harvested each year is equal to or less than the fishing quota;
- **selling:** the harvest is sold.

Communities advocated for the addition to the co-management plan of 'customary use of arapaima' for special occasions. Communities celebrate Amerindian Heritage month every September and believe it is important to share a meal consisting of arapaima for this celebration to support and strengthen community bonds.

The harvesting of arapaima is not allowed from 1 March to 30 November each year – the time when adults reproduce – except for customary use. However, the co-management committee, in consultation with community fishery committees, will decide on the days and lakes, and whether fishers can harvest one or two arapaima to be provided to their communities under customary use. Such harvests should avoid any arapaima guarding their young.

Each community fishery committee can assign its most experienced arapaima fisher to the task, and ensure against any separate arapaima fishing events by any other member of the community.

©Brent Stirton/Getty Images for FAO, CIRAD, CIFOR-ICRAF and WCS
NRDDB rangers interview a local fisher

Monitoring of the fisheries sector

Communities, with some assistance from national agencies, can begin to monitor at three levels if resources permit.

1. The use of fish stocks in the communities: the first step in understanding the fish stock involves understanding what is being extracted from the fish populations. The co-management committee, through community fishery committees, will record the catch (time invested in fishing, species caught, number of individuals, weight and the distance travelled) from communities. This data collection will occur every week for one or two months per season (dry and wet) to obtain an estimate of the quantity of fish extracted per community.

2. Patrolling of the management area: patrolling will be the responsibility of community fishery rangers or other representatives appointed by the co-management committee to ensure everyone is following the guidelines when fishing. Monitoring will also be critical for deterring non-resident fishers from fishing within the co-management area.

» Assessment of the fish stocks: can be done for specific locations and for specific species, such as those that are targeted for commercial purposes, to monitor the stocks. This assessment can be done every three years, but Local Ecological Knowledge (LEK) assessments can be done every year. However, data shall consider the start of the rainy season and after the rainy season to establish the productivity of the system and attempt to estimate the removal rate from the recruited population. This assessment can be supplemented by the data collected in the villages from fishers.

Raising awareness

The fisheries monitoring will go hand in hand with an awareness campaign aimed at ensuring guidelines for sustainable use of fish resources are respected. Within this campaign, a range of activities and products are planned. First, village meetings will be conducted in a workshop-style format, followed by reminders at public meetings. These interactive meetings will offer community members a chance to engage and seek clarification on any questions they may have. To ensure the guidelines are accessible to all, signboards will be placed in public spaces, and house visits will be conducted by members of the fishery committee/resource management group, with the assistance of Makushi researchers, to explain the guidelines in the local language. Additionally, posters, flyers and brochures will be distributed or displayed in public spaces, while videos will be created and shared on social media platforms such as Face-

©FAO/Luke McKenna
NRDDB fisheries officer, Susan George, identifies a fish before releasing it

book. To reach an even broader audience, a series on fisheries management can be broadcast on the local radio station (Radio Paiwomak). Finally, community members will be entrusted with the responsibility of ensuring that their neighbours are aware of and respect the guidelines.

Conclusions and recommendations

The Co-management Plan for Fisheries in the North Rupununi Wetlands 2023 is a sustainable development initiative that addresses ecological, social and economic aspects of development in the North Rupununi region.

Its guiding principle is that the local social organization will be supported as local people work to conserve and sustainably manage a natural resource that is critical for their survival. This co-management plan is developed within the general framework of the Co-management Policy for Inland Fisheries and Aquaculture in Guyana. The types of fisheries in the North Rupununi Wetlands fisheries co-management area covered under this plan include: food fisheries (subsistence/customary use/commercial), aquaculture fisheries, aquarium fisheries, and sport fishing/recreational fisheries.

It is advisable that the plan be revised every five years from the date communities agree to implement the Co-management Plan for Fisheries in the North Rupununi Wetlands 2023. This timeframe may allow local communities to make adaptive adjustments based on lessons learned, and to accommodate future changes in the status of the fishery. The plan recognizes the role of traditional knowledge in the management of exploited fish populations, considers the relevance of conserving the traditional and cultural use of fish, and promotes the recognition and involvement of youth and women with a stake in the future of the region's fisheries.

The Co-management Plan for Fisheries in the North Rupununi Wetlands 2023 requires an adaptive management approach that acknowledges the uncertainty and complexity that exist in any socioecological system. Adaptive management is a structured approach for learning from success and failure, and for making the required adjustments so that sustainability can be achieved.

The plan will be implemented as soon as a co-management arrangement is signed between the co-management committee and the Minister of Agriculture representing the Fisheries Department. The plan will be implemented by the North Rupununi Wetlands Co-management Committee with ground support from the various community fishery committees. The committees will ensure that all residents are aware of the plan and understand how it works.

©FAO/Luke McKenna
An evening of fishing in Yupukari village

Wildlife clubs in North Rupununi

By Ivor Marslow, North Rupununi District Development Board

Environmental education in Guyana's North Rupununi began in 1998 through the establishment of community wildlife clubs. These clubs were successful in their early years, but eventually experienced a decline in activity, until 2019 when SWM and the North Rupununi District Development Board helped to revive and reactivate them. Since 2019, six communities – Wowetta, Surama, Rewa, Fairview, Kwaimatta and Yupukari – have been actively delivering environmental awareness programmes to their youth through wildlife clubs. These involve groups of children and youth that meet on a regular basis and, facilitated by a club coordinator, implement a range of environmental education and citizen-science activities in relation to wildlife. The clubs' main objectives are: develop awareness and understanding of plants, animals, forests and savannahs of the Rupununi; develop capacities for performing local wildlife inventories and monitoring; foster an understanding of natural resource management and conservation; and build personal capacity and social skills.

Club members are generally between the ages of eight and 20 years old, although individuals of any age can participate. Clubs are run by a locally elected executive committee of peers that provides an opportunity for members to develop their leadership skills. Older club members often become club coordinators, who mentor younger members. Community elders provide guidance and share traditional knowledge. Clubs meet twice a month, after school or on weekends, and activities are conducted in the immediate surroundings of the particular village. Activities can range in duration from short (four hours) to all day, and the number of participants varies from as few as six to as many as 45.

Activities are planned in collaboration with youth members, according to the individual club's goals and building upon three fundamental pillars: responsibility, respect, and self-care. These activities range from counting arapaima to bird-watching, camera trapping, forest hikes and clean-up campaigns. Clubs have a particular interest in citizen science, which involves integrating observations, data collection, analysis and sharing of findings.

©FAO/Marlondag
Young members of Yupukari Wildlife Club looking for birds in the early morning

©FAO/Marlondag
Wildlife club members note down a blue-grey tanager they spotted

4.2. Wapichan Wiizi Wildlife Management Plan

Contributors: *Timothy Williams[1] Nathalie van Vliet[2], Kid James[3], Neal Millar[4], Oswin David[5]*

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[6] Sustainable Wildlife Management (SWM) Programme Guyana; Guyana Wildlife Conservation and Management Commission (GWCMC)

Highlights

- Wildlife and aquatic resources are an integral part of Wapichan identity, livelihoods and culture, and therefore deserve special attention in terms of management and conservation efforts.
- Since the early 2000s, several conservation initiatives have been implemented in the Wapichan Wiizi to protect wildlife and fisheries, and ensure their sustainable use.
- These initiatives have been consolidated and expanded with support from the Sustainable Wildlife Management (SWM) Programme, and structured within the Wapichan Wiizi Wildlife Management Plan (WWWMP).
- The management plan was developed from March 2022 to October 2022, guided by wildlife use surveys and wildlife population assessments carried out by the SWM Programme, grey literature, as well as extensive consultation with community members and relevant stakeholders.
- The plan is implemented by village councils with support from the Wapichan Wiizi Wildlife Committee (WWWC) and several local civil society organizations in coordination with the Guyana Wildlife Conservation and Management Commission (and other relevant governmental institutions).

©FAO/Marlondag
Local ranger from Karaawaimin Taawa biodiversity assessment beside a silk cotton tree

- The management plan is structured around six main objectives:
  - Wapichan peoples' rights and customary territory are legally recognized;
  - local leaders are empowered to manage and conserve wildlife and fisheries in a coordinated effort;
  - wildlife is managed sustainably;
  - traditional and scientific knowledge is available to inform wildlife management decisions;
  - community members and the youth understand wildlife management issues and have positive attitudes towards management and conservation initiatives; and
  - alternative livelihoods and sustainable business models are available for communities.

Introduction

Starting in 2008, the Wapichan communities in Guyana initiated an extensive and collaborative process to develop a territorial management plan, culminating in 2012 with the publication of *Baokopa'o wa di'itinpan wadaun nii nao ati*[4] *(Thinking together for those coming behind us).* Since its publication, the territorial management plan has been guiding practices and management decisions over Wapichan land and livelihoods. It has also been instrumental in shaping the common vision of the Wapichan communities, particularly advocating for the legal recognition of customary lands, promoting the sustainable use of resources, preserving and transmitting customary laws and traditional practices, achieving self-sufficiency and food security, and fostering respect for Wapichan culture and traditional institutions.

As emphasized in the territorial management plan, terrestrial and aquatic wildlife is a key element of Wapichan livelihoods, culture, values and beliefs. As such, it is often incorporated into food, medicine, stories and ornaments. It is an integral part of Wapichan identity and therefore deserves special attention in terms of management and conservation efforts. Since the early 2000s, several initiatives have been implemented in Wapichan Wiizi (the traditional territory of the Wapichan people in Guyana) to protect wildlife and ensure its sustainable use. These include the monitoring of the red siskin (*Spinus cucullatus*), biodiversity assessments in the Kusad and Parabara mountains, mammal/fish/turtle surveys, jaguar population assessments, and monitoring of hunting. Since 2019, these initiatives have been consolidated and expanded with support from the Sustainable Wildlife Management (SWM) Programme. The Wapichan Wiizi Wildlife Committee (WWWC) works closely with local partners such as the South Rupununi Conservation Society (SRCS), the Rupununi Livestock Producers Association (RLPA) and Visit Rupununi (VR). In 2022, to further strengthen its wildlife management efforts, the WWWC – together with all communities that are part of the Wapichan Wiizi and local partners – decided to develop a wildlife management plan. This plan is aligned with the broader territorial management plan, ensuring coordinated and sustainable efforts to protect and manage terrestrial and aquatic wildlife in the region.

In this chapter, we present the ten-year management plan for the protection and sustainable use of terrestrial and aquatic wildlife within the Wapichan Wiizi. The plan is implemented on a voluntary basis by village councils with support from the Wapichan Wiizi Wildlife Committee and local organizations, SRCS, VR, RLPA; and in coordination with the relevant governmental organizations such as the Guyana Wildlife Conservation and Management Commission (GWCMC), the Fisheries Department - under Ministry of Agriculture Guyana, the Protected Areas Commission (PAC) and the Environmental Protection Agency (EPA).

[4] South Central and South Rupununi Districts Toshaos Councils, Baokopa'o wa di'itinpan wadaun nii nao ati: Kaimanamana'o, wa zaamatapan, wa di'itapan na'apamnii wa sha'apatan Wapichan wiizi Guyana'ao raza/Thinking together for those coming behind us: An outline plan for the care of Wapichan territory in Guyana (2012), at iv, available at https://www.forestpeoples.org/sites/fpp/files/publication/2012/05/wapichan-mp-22may12lowresnomarks.pdf (last visited 4 November 2023)

Table 24. List of priority species included in the management plan

Common names	Scientific names
WATER ANIMALS	
Arowana	*Osteoglossum bicirrhosum*
Swordfish	*Boulengerella cuvieri*
Tiger fish	*Pseudoplatystoma* sp.
Lukanani	*Cichla ocellaris*
Haimara	*Hoplias aimara*
Spectacled caiman	*Caiman crocodilus*
Black caiman	*Melanosuchus niger*
Red pacu	*Myleus pacu*
Giant otter	*Pteronura brasiliensis*
Toadhead turtle	*Mesoclemmys gibba*
Twist-necked turtle	*Platemys platycephala*
Mata mata	*Chelus fimbriata*
Painted wood turtle	*Rhinoclemmys punctularia*
Giant South American river turtle	*Podocnemis expansa*
Yellow-spotted river turtle	*Podocnemis unifilis*
TERRESTRIAL ANIMALS	
Jaguar	*Panthera onca*
Oncilla	*Leopardus tigrinus*
Red brocket deer	*Mazama americana*
Amazonian brown brocket deer	*Mazama nemorivga*
White-tailed deer	*Odocoileus virginianus*
Grey (brown) brocket deer	*Mazama gouazoubira*
White-lipped peccary	*Tayassu pecari*
Collared peccary	*Dicotyles tajacu*
Giant anteater	*Myrmecophaga tridactyla*
Silky anteater	*Cyclopes didactylus*
Southern tamandua	*Tamandua tetradactyla*
Yellow armadillo	*Euphractus sexcinctus*
Southern naked-tailed armadillo	*Cabassous unicinctus*
Northern naked- tailed armadillo	*Cabassous centralis*
Nine-banded armadillo	*Dasypus novemcinctus*
Greater long-nosed armadillo	*Dasypus kappleri*
Seven-banded long-nosed armadillo	*Dasypus septemcinctus*
Giant armadillo	*Pridontes maximus*
Tapir (lowland)	*Tapirus terrestris*
Capybara	*Hydrochoerus hydrochaeris*
Labba	*Cuniculus paca*
Howler monkey	*Alouatta macconnelli*
Bush dog	*Speothos venaticus*
Blue poison dart frog	*Dendrobates tinctorius azureus*
Red-footed tortoise	*Chelonoidis carbonarius*
Pinktoe tarantula	*Avicularia avicularia*
Skeleton tarantula	*Ephebopus murinus*
Yellow-footed tortoise	*Chelonoidis denticulatus*
Hoary-throated spinetail	*Synallaxis kollari*
FLYING ANIMALS	
Harpy eagle	*Harpia harpyja*
Chestnut-bellied seed finch	*Oryzoborous angolensis*
Red siskin	*Spinus cucullatus*
King vulture	*Sarcoramphus papa*
Twa-twa	*Oryzoborous crassirostris*
Powis	*Craxs alector*
Blue -and- yellow macaw	*Ara ararauna*
Red -and- green macaw	*Ara chloropterus*
Red-bellied macaw	*Orthopsittaca manilata*
Red-shouldered macaw	*Diopsittaca nobilis*
Scarlet macaw	*Ara macao*
Guianan cock-of-the-rock	*Rupicola rupicola*
Hawk-head parrot	*Deroptyus accipitrinus*
Amazonian umbrella bird	*Cephalopterus ornatus*
Toco toucan	*Ramphastos toco*
Red-billed toucan	*Ramphastos tucanus*
Rio Branco antbird	*Cercomacra carbonaria*
Bearded tachuri	*Polystictus pectorals*

Source: Williams et al. 2023. SRDC.

Objectives, scope and approach of the management plan

The management plan serves as a comprehensive framework for future actions towards the sustainable use and conservation of terrestrial and aquatic wildlife in the Wapichan Wiizi. This ten-year plan provides an overarching structure to guide decision-making processes for present and future village councils on the management of terrestrial and aquatic wildlife within the Wapichan Wiizi. The plan can also be used to collectively search for funding, scientific partnerships, network with other communities with similar goals, and lobby for national support with regard to any aspect stated in the plan. It is aligned with the wider objectives of the WWWMP and contributes towards its implementation.

The WWWMP covers all terrestrial and aquatic wildlife present within the Wapichan Wiizi. However, a particular focus is placed on the species that are important for the livelihoods and cultural identity of the Wapichan people as well as endemic species, species with worldwide conservation interest, and species that are not yet well-known to science (see Table 24).

The shared vision guiding the development of the management plan can be summarized as follows:

"Our dream is to see the entire Wapichan territory legally recognized, and our communities empowered to implement a functional plan for the sustainable use of wildlife and fisheries and the conservation of our biodiversity". *(by participants in the workshop for the development of the Wapichan Wiizi Wildlife Management Plan, Aishalton, Guyana)*

This WWWMP is a community-driven effort to contribute to national level-policies and legislation on wildlife and fisheries management and conservation.

It was developed over a period of eight months from March 2022 to October 2022. It is founded on baseline information found in the literature, wildlife use surveys and population assessments, and an extensive consultation with community members and relevant stakeholders. The participation of women was encouraged throughout the consultation and development process, and particular attention was given to ensuring their views were well represented in the WWWMP. The consultation was based on an internal decision process among the Wapichan leaders, and followed the principles of free, prior and informed consent (FPIC), which included the following steps:

Step 1: Awareness-raising: Posters with guidelines for community wildlife and the national list of protected species in Guyana were distributed in all communities. A brochure explaining the role of the WWWC was distributed during village-and district-level meetings. Short messages about the management plan were aired on local Radio Aishalton twice per month, beginning in November 2021. Live interviews were conducted to inform community members about the progress made, and to share news regarding local and national wildlife initiatives and other educational content. Thus, radio played a key role in disseminating information about the plan to villages. Finally, representatives from the SRDC also made in-person presentations at village general meetings – disseminating information and addressing concerns and questions from community members.

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SRDC members discuss objectives for the Wapichan Wiizi Wildlife Management Plan

Step 2: Multistakeholder workshop: The workshop took place in Aishalton in March 2022 to set the foundation for drafting the WWWMP. Participants included Toshaos (community leaders), members of the WWWC, SRDC leaders, representatives of women's groups, local NGOs (SRCS, VR, RLPA), community development officers (CDOs), one representative of the Ministry of Amerindian Affairs, and the Regional District Council. The workshop was facilitated by technical experts from the SWM Programme, and consisted of three phases: a game session to introduce the discussion around the sustainable use of wildlife and the role of collective action; a series of presentations about current wildlife management and conservation activities within the Wapichan Wiizi; and a theory of change exercise. To advance the planning process, participants were divided in two groups to define the boundaries of the territory where the management plan would apply; identify the species that should be part of it; and pinpoint the stakeholders that should be involved in the consultation and validation process. Stakeholders were ranked according to their levels of influence and interest. The final session of the workshop focused on creating a joint vision of the future of people and wildlife in the Wapichan Wiizi and a road map detailing the actions needed to achieve that vision. Participants defined the vision, the general and specific outcomes, and the activities that would lead to such outcomes, slowly building a comprehensive draft road map.

Step 3: Draft management plan: This plan was ratified and revised by each of the villages during village-level engagements and shared with local NGOs involved in implementation of activities mentioned in the management plan. This iterative process continued from April 2022 to February 2023 and culminated in another round of village-level meetings for endorsement of the management plan.

Step 4: Validation: Finally, in March 2023, the WWWMP was validated and launched.

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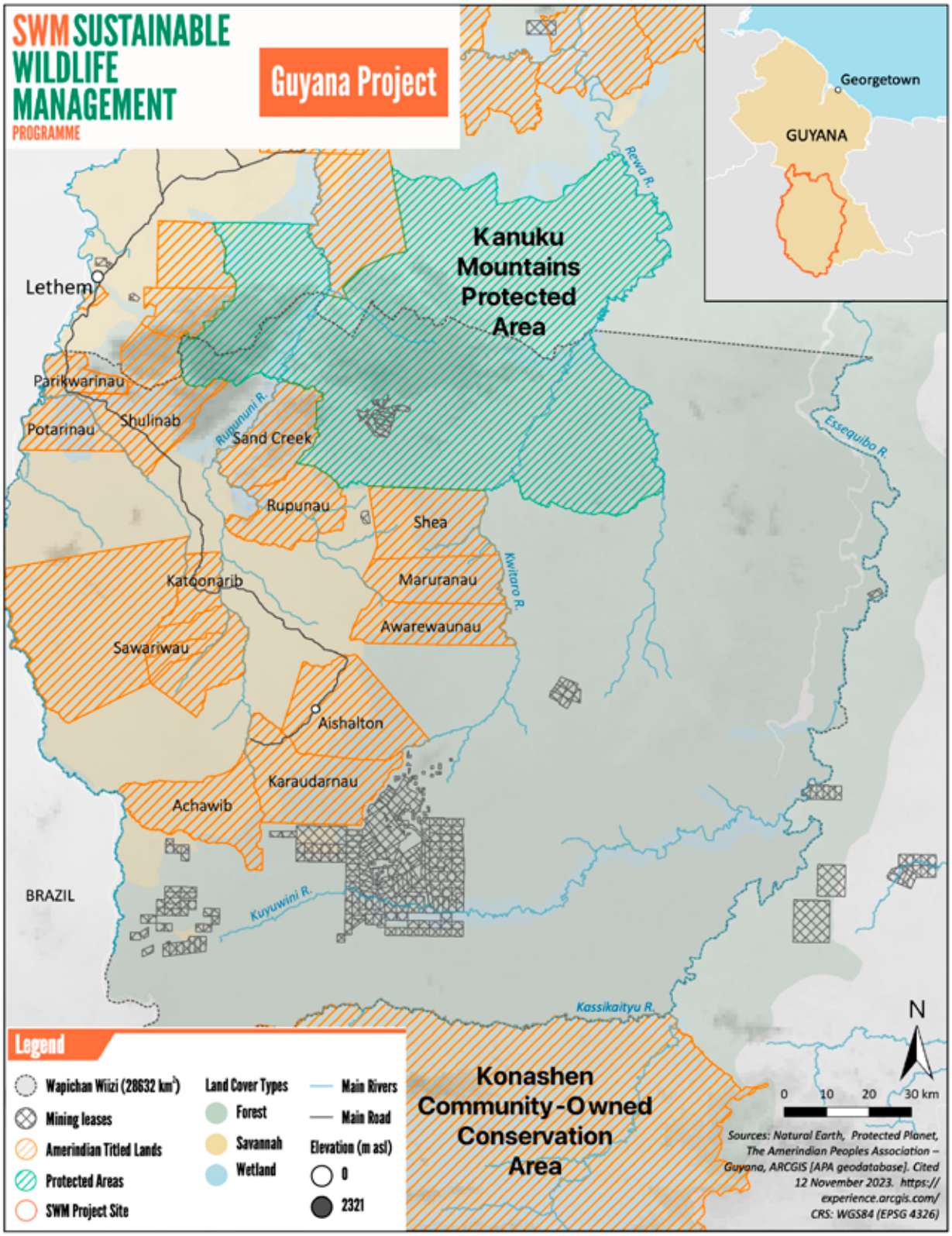
Takatu River with Guyana on the left and Brazil on the right

Figure 38. Map of the Wapichan Wiizi



The boundaries and names shown and the designations used on this/these map(s) do not imply the expression of any opinion whatsoever on the part of FAO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers and boundaries. Dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Description of the Wapichan Wiizi

The Wapichan Wiizi (see Figure 38) at 28 632 km^2 represents the full extent of the traditional territory of the Wapichan people. It is located in South Rupununi between three rivers: the Takutu (which is the Guyana-Brazil border), the Kassikaiytu and the Essequibo. The land includes the southern part of the Kanuku Mountains. Wapichan Wiizi harbours a highly diverse habitat with continuous tracts of primary forest, 'bush islands', gallery forests, open and tree savannah, and seasonally flooded wetlands. Phytogeographically, the Wapichan Wiizi represents an extension of the Rio Branco savannahs in Brazil, and is therefore distinct from other parts of Guyana (Jansen-Jacobs and ter Steege, 2000). The Wapichan Wiizi lies on one of Guyana's unique and diverse ecosystems, and is one of the last great wilderness areas on Earth. It is home to many species that are highly endangered globally. These include many iconic Amazonian species: the jaguar (*Panthera onca*), giant river otter (*Pteronura brasiliensis*), harpy eagle (*Harpia harpyja*), Brazilian tapir (*Tapirus terrestris*), giant anteater (*Myrmecophaga tridactyla*) and giant armadillo (*Priodontes maximus*). The Wapichan Wiizi comprises the South Central and the Deep South Districts, with 21 communities. Only 13 of those communities hold title to a portion of their customary lands, while the rest of the territory has yet to be legally recognized by the government. Overall, the titled lands comprise only a portion of the full territory.

Governance for the Wapichan Wiizi Wildlife Management Plan

The WWWMP sets general objectives towards which Wapichan communities and their local partners have agreed to work in a collaborative manner. Governance for the implementation of the plan involves the village councils, the WWWC, local civil society organizations and the relevant governmental institutions.

Village councils: Village councils are the only governance institutions with a legitimate mandate to take decisions over the land, resources and people within their village titled land. Village councils may establish a wildlife/fisheries committee as the local implementing team or advisory body for the WWWMP. In consultation with community members, the village council voluntarily develops village wildlife/fisheries rules, guidelines or action plans guided by the overarching plan. For enforcement at the local level, Toshaos, the village council and the community itself (through village meetings) represent the traditional institutions in charge of settling disputes.

Wapichan Wiizi Wildlife Committee: The WWWC was established in 2019 by the SRDC to promote conservation and sustainable management of wildlife species and habitats across the Wapichan Wiizi. The activities of the committee encompass raising public awareness about conservation and sustainable management of wildlife; incorporating traditional knowledge into conservation and sustainable management of wildlife; empowering communities to make informed wildlife management decisions through studies of species with high conservation value; exploring wildlife livelihood opportunities; and assisting village councils in establishing rules for the protection, conservation and sustainable management of wildlife. In the context of the management plan, the committee will serve a facilitation role on the stakeholder platform, including village councils, governmental institutions and the wider civil society.

Key civil society partners: Several local civil society organizations are supporting the implementation of this plan. These include the SRCS for its expertise in environmental education, wildlife monitoring and research. SRCS is considered one of the leading grassroots conservation NGOs in Guyana, advancing the preservation of the wildlife, environment and culture of the Rupununi through community-based conservation, research and environmental education. Its members – many of whom are local Indigenous Peoples of the South Rupununi – have been part of trainings, expeditions and projects within the Wapichan Wiizi over the past few decades, and therefore have a wealth of expertise on research methodologies as well as

project design and management. In addition, SRCS has successfully collaborated with multiple communities within the Wapichan Wiizi on a number of projects. SRCS will therefore be a key partner for the successful implementation of the management plan. The partnership between SRCS and SRDC was bolstered by the signing of an MoU between the two organizations to lead a coordinated approach to sustainably preserve the culture, wildlife and environment of the South Rupununi.

Visit Rupununi (VR) is included for its expertise in wildlife-based tourism and its work raising awareness of sustainable wildlife management, wildlife protection and social responsibility. VR markets the tourism value of the region through its established platform that reaches out to the people of the region, especially in those areas that overlap with the integrity and uniqueness of the region's landscape. It also places particular importance on the integrity and respect of Indigenous People's lives, culture and rights as intrinsically linked to the experimental and cultural tourism that VR is promoting in the region. Because of this, VR can assist SRDC with visibility, accountability and marketing on aspects of the management plan that intersect with tourism; in particular, within private sector forums.

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RLPA project coordinator, Ayla Kenyon, delivers a batch of eggs to the hatchery

The Rupununi Livestock Producers Association (RLPA) is included for its expertise in livestock production and marketing as potential alternative livelihoods in Wapichan communities. RLPA works with Wapichan communities and supports the local livestock industry through lobbying and the promotion of technical and marketing improvements. It also supports and coordinates the development of holistic and sustainable approaches to pasture development and management within the landscape's environmental limits, breed improvement, improved animal husbandry, and marketing opportunities for communities and livestock farmers.

Key governmental partners: The key governmental partners involved in the implementation of this plan are the GWCMC and the Fisheries Department. However, its implementation will require close coordination with the Protected Areas Commission (PAC), the Environmental Protection Agency (EPA), the Ministry of Amerindian People's Affairs (MAPA) and the Guyana Livestock Development Authority (GLDA).

Management for the sustainable use and conservation of wildlife and fisheries

The key assumptions guiding the development of this plan are as follows:

- By legally ensuring the recognition of the Wapichan territory and building capacities at the community level concerning the right to free, prior and informed consent (FPIC) and community-based rights approaches, the plan contributes to preserving the territory on which terrestrial and aquatic wildlife depends.
- By strengthening village councils, ensuring continuity between Toshao mandates, and establish-

ing a platform for coordinated actions between all stakeholders with an interest in wildlife and fisheries management, the plan empowers the Wapichan community and establishes good governance over the management of terrestrial and aquatic wildlife within the territory.

- By increasing awareness on sustainability concepts, developing a research agenda that bridges traditional and scientific knowledge, investing in environmental education and developing diversified sources of protein, the plan promotes community buy-in for the sustainable use of wildlife and fisheries within its territory.
- By advocating for the mitigation of impacts caused by mining and other development projects within the territory, establishing conservation zones, encouraging village councils to establish and enforce rules on use of wildlife and fisheries, and protecting biodiversity hotspots, the plan contributes to maintaining healthy terrestrial and aquatic wildlife populations for future generations.

The WWWMP is structured around six main objectives :

Objective 1: Wapichan peoples' rights and customary territory are legally recognized

The right to FPIC is respected: SRDC, with support from partners, will continue to build capacities within the communities, particularly with regards to understanding and exercising their rights, including the right to FPIC. This will entail raising awareness about FPIC at the community level (e.g. workshops with village councils that will then conduct trainings with the rest of the community members) and support villages in the development of their village-level FPIC rules.

The Wapichan co-management agreements are officially recognized: The SRDC, through the WWWC and other partners engaged in the implementation of this plan, will work with the GWCMC for the legal recognition of co-management wildlife agreements and the development

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Elvis Joseph, an SRDC member and Wapichan hunter

of a co-management policy for wildlife. In parallel, the WWWC will engage with the Department for Inland Fisheries to establish a fisheries co-management zone within the Wapichan Wiizi following the National Co-management Policy for Inland Fisheries validated in 2023.

The Wapichan land rights are granted: The SRDC and villages will continue to advocate for the full legal recognition of their right to own, use, control and develop their traditional lands, territory and resources.

Objective 2: Local leaders are empowered to manage and conserve wildlife and fisheries in a coordinated effort

Village councils are at the centre of the WWWMP: Village councils are the most important governance body within each community and their role is to inspire respect for the rules to protect the Wapichan Wiizi and its resources. Village councils will continue to play a key role in fostering unity within the community and between communities in the Wapichan Wiizi. Toshaos will ensure continuity across mandates in terms of wildlife and fisheries management, and work towards establishing transition periods between Toshao mandates.

©FAO/Luke McKenna
Shulinab village's giant anteater conservation zone

Village councils have better control over wildlife use: The SRDC, in collaboration with village councils and the GWCMC, will put in place a checkpoint controlling access to the Wapichan territory, and control and monitor the trade of wildlife and the extraction of other resources and goods.

Village councils will communicate and enforce existing village-level wildlife and fisheries management guidelines in their titled land. They will ensure compliance with locally agreed rules within their communities. Village councils will jointly develop rules on shared use areas, expanding upon their common boundary agreements.

Future leaders are trained: SRDC and SRCS will continue to train the youth to become efficient local leaders.

The local civil society network is consolidated: Local wildlife - and fisheries-related organizations (such as SRCS and the SRDC through the WWWMP committee) will increase their technical capacities, their functional structure, and their fund-raising know-how to ensure continuity of activities over the long term.

Objective 3: Wildlife is managed sustainably

Rules for sustainable use are enforced, and terrestrial and aquatic wildlife use is monitored: Where not yet in place, village councils will develop village-level wildlife and fisheries use rules to ensure sustainable use. This will be done with support from SRDC through the WWWC. A process will be put in place to mainstream guidelines that apply across the landscape. These village-level rules will be revisited every year based on new information available. The SRDC, through the WWWC, will put in place a stewardship system. Hunters and fishermen in each community will be identified to play a central role as 'wildlife and fisheries stewards'. On a voluntary basis, village councils will consolidate their river turtle conservation and sustainable use efforts along the Rupununi River, and participate in the development of the river turtle management plan with the technical support from the SRCS.

Community conservation areas are created: On a voluntary basis, each village council will determine the criteria for the establishment of conservation zones, including the numbers of areas, size, their delineation, rules, etc., in some cases with the assistance from technical experts. Village councils that have already created conservation zones within their lands e.g. Katoonarib and Shulinab giant anteater community conservation zones will consolidate their implementation. The SRCS will serve as a technical advisor for this activity and support the recognition of these areas at the regional and national level.

Human–wildlife conflicts are mitigated: Village councils, in partnership with SRCS, scientific organizations and the GWCMC, where necessary, will develop a strategy to deal with animals that cause damages to crops or livestock or represent a threat to human lives.

Objective 4: Traditional and scientific knowledge is available to inform wildlife management decisions

Information relevant to management is generated to guide our decisions: A joint wildlife and fisheries research plan will be developed to increase scientific knowledge on terrestrial and aquatic wildlife, map traditional knowledge on wildlife and fisheries, and better understand the relationship between people and terrestrial and aquatic wildlife. Partnerships with scientific and research institutes will be encouraged.

Village councils, in close collaboration with the WWWC, and with support from external partners, will implement multi taxa assessments in bioculturally rich areas, such as the assessments already carried out in Parabara, Karaawaimin Taawa and Kusad Mountain, and closely monitor these rich areas for their protection.

Village councils have access to key sources of information: SRDC will consolidate wildlife and fisheries libraries in a selected number of villages across the Wapichan Wiizi to ensure that information on wildlife and fisheries is made available to community members.

SRDC will facilitate access to good satellite (or drone) images to map the current extent of forest, fire damage, current farm areas, secondary growth, etc., and train councils in the use of GIS and other such imagery in decision making.

Factors influencing terrestrial and aquatic wildlife populations are monitored: The SRDC, through the WWWC, will put in place a monitoring system. Hunters and fishermen in each community will be identified to monitor biodiversity-rich areas, monitor terrestrial and aquatic wildlife use and trade, and monitor populations of certain key species. SRDC will continue to monitor mining areas and develop an advocacy plan to reduce the impacts of gold mining on wildlife and fisheries.

Objective 5: Community members and the youth understand wildlife management issues and have positive attitudes towards management and conservation initiatives

Youth understand the importance of wildlife and fisheries for the Wapichan culture and ways of life: SRCS, in close collaboration with village councils and schools, will continue to take the lead in environmental education in schools and through traditional knowledge classes.

The plan contributes to raising awareness about wildlife and fisheries issues at national and international levels: Village councils, with support from SRCS and SRDC, will continue to raise awareness about wildlife and fisheries management initiatives through various communication means. A communication and awareness plan will be developed on a yearly basis. The WWWC will ensure that lessons learned through the implementation of the WWWMP will be shared. The platform will play a key role in ensuring cross-country and inter-community exchanges.

Objective 6: Alternative livelihoods and sustainable business models are available for communities

Alternative sources of protein are available to guarantee food security: Village councils will

work with RLPA and the Guyana Livestock Development Agency/National Agricultural Research Extension Institute to reduce dependency on wildlife for food and develop alternative sources of protein.

Village councils will partner with key organizations to encourage youth to take part in training and exchange programmes with regards to the diversification of livelihoods that are compatible with the conservation of wildlife.

Businesses based on sustainable use are explored: In order to ensure that the sustainable use of wildlife can contribute to local livelihoods, avenues to develop wildlife-based, sustainable-use initiatives based on five dimensions of sustainability (environmental, economic, social, human health and animal welfare) will be explored and piloted.

Wildlife-based tourism becomes a sustainable livelihood option: Village councils will work together with VR to ensure that conservation efforts are rewarded by revenues from wildlife friendly tourism, and that the region can continue to be promoted with "Keep the Rupununi Wild".

Conclusions and recommendations

Wildlife is an integral part of the Wapichan culture and way of life. It deserves particular attention and specific management and conservation strategies. Through the WWWMP, communities have identified a vision for terrestrial and aquatic wildlife and people within the Wapichan Wiizi: "Our dream is to see the entire Wapichan territory legally recognized, and our communities empowered to implement a functional plan for the sustainable use of wildlife and the conservation of our biodiversity". The plan is implemented over the whole extent of the customary land of the Wapichan, beyond titled land. As such, the implementation of this plan requires a close collaboration between communities and governmental institutions in charge of wildlife management in the national territory, particularly with the GWCMC and the Fisheries Department. Communities will implement this plan through their community wildlife and fisheries management committees in close collaboration with the WWWC and civil society organizations established in the Rupununi. This plan serves as an overarching framework that consolidates a united vision and strategy for the conservation and management of terrestrial and aquatic wildlife over the next ten years within the Wapichan Wiizi.

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Basket weaving is a traditional craft for the Wapichan people

Karaawaimin Taawa biocultural survey

By Timothy Williams, South Rupununi District Council

The Karaawaimin Taawa, also known as Blue Mountains, is a range located within the Wapichan territory of the Aishalton extension area, where it forms part of the greater Marudi Mountain range. It holds immense cultural significance for the Wapichan people, who have used it as a traditional fishing, hunting and gathering ground for generations. The Karaawaimin Taawa also serves as a crucial watershed that makes up a significant portion of the headwater system of the Essequibo River, Guyana's largest and longest river and its main freshwater source. Unfortunately, unsustainable land uses and, particularly, irresponsible mining are increasingly threatening this ecosystem and the services it provides to the Wapichan people and to the wider community.

In 2019, recognizing the necessity to safeguard the Karaawaimin Taawa, community members in Aishalton held a public meeting and decided to take action to preserve the mountain range and manage it in accordance with Wapichan customs and history. Leaders from Aishalton sought support from the South Rupununi District Council (SRDC) and the Sustainable Wildlife Management (SWM) Programme to support a biocultural assessment of the area. The assessment aimed at drawing attention to the region's biodiversity and its cultural ties to the Wapichan people, while highlighting the vital role that communities play in safeguarding their lands and resources.

The assessment focused on seven taxonomic groups, and identified a diverse array of wildlife in the area, including 228 bird species, 48 terrestrial mammal species, 75 fish species, 30 amphibian species, 29 reptile species, more than 96 aquatic beetle species and about 11 genera of dung beetles. The study also revealed that the Karaawaimin Taawa cultural landscape is associated with lived experiences, events and people, and that it holds deep cultural and spiritual values intertwined with the Wapichan people's worldview.

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SRDC monitor walks through the forest of the Karaawaimin Taawa

©FAO/Marlondag
Landscape view of the Karaawaimin Taawa

4.3. Management of river turtles in the Rupununi

Contributors: *Neal Millar[1], Anthony Roberts[2], Fran Braga[3], and Nathalie van Vliet[4]*

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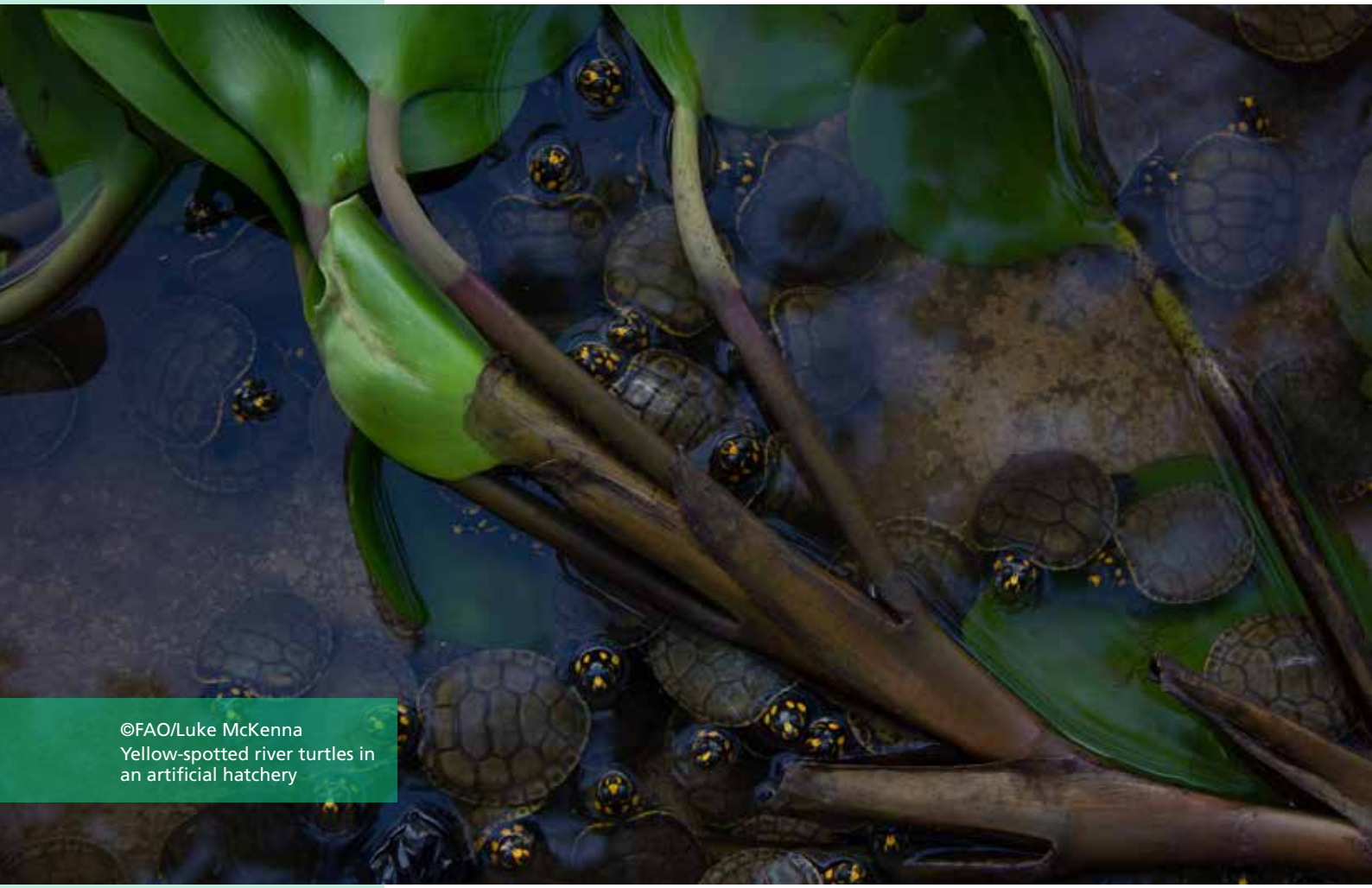
Highlights

- Over the last 20 years, communities have become increasingly concerned about the decline of river turtle populations in the Rupununi region of Guyana, prompting a surge in grassroots conservation initiatives.
- Caiman House Inc., a non-governmental organization (NGO) managed by Yupukari village, initiated the first conservation efforts to protect the yellow-spotted river turtle (*Podocnemis unifilis*) through *ex situ* conservation.
- Sand Creek village followed, establishing *in situ* conservation initiatives through the support of the South Rupununi Conservation Society (SRCS) and the Sustainable Wildlife Management (SWM) Programme.
- The successful models implemented in Yupukari and Sand Creek led to the development in 2022 of a ten-year regional river turtle management plan aimed at preserving river turtles and ensuring their sustainable use.
- The regional plan was designed through an exemplary consultation process, which involved stakeholders at the local, regional and national levels.



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Yellow-spotted river turtles in an artificial hatchery

Introduction

The conservation and recovery of increasingly threatened tropical freshwater turtle populations depends on effective management plans and actions (Norris *et al*., 2020). In the Rupununi region, the perceived decline in river turtle populations over the last 20 years has incentivized local communities and grassroots civil society organizations to engage in river turtle protection and monitoring activities. In 2011, a turtle conservation programme was initiated in Yupukari village in North Rupununi, with the support of Caiman House Incorporated (CHI). Around the same time, Sand Creek village in South Rupununi also expressed interest in turtle conservation, but due to a lack of funding, no long-term initiative was established. However, since 2019, the Sustainable Wildlife Management (SWM) Programme has provided technical and financial support to CHI and the South Rupununi Conservation Society (SRCS) to facilitate the development of comprehensive conservation initiatives for river turtles in the Rupununi. These initiatives include *in situ* conservation through beach protection and monitoring, and *ex situ* conservation with head-starting activities, monitoring of turtle consumption, and environmental education. Due to the success of these initiatives and the need to reverse the perceived population decline, communities from North and South Rupununi joined forces in 2022 to develop and implement a regional river turtle management plan. In the following sections, we describe the Yupukari conservation programme, more recent conservation efforts in Sand Creek, and the collective process involved in creating a Rupununi river turtle management plan.

The turtle management project in Yupukari, North Rupununi

Freshwater turtle management and conservation efforts in the Rupununi region began with CHI, a grassroots non-governmental organization (NGO) managed by Yupukari village in North Rupununi. In 2011, CHI initiated a conservation project aimed at protecting the yellow-spotted river turtle (*Podocnemis unifilis*) (Rosenblatt *et al*., 2021) in response to community concerns about the declining turtle population due to overconsumption of turtle meat and eggs, disturbance by natural predators and flooding. The project gained momentum due to other ongoing conservation initiatives being implemented by CHI, such as black caiman (*Melanosuchus niger*) research and conservation (Pierre *et al*., 2022). Since 2019, its turtle conservation efforts have been supported and scaled up with funding and technical support from the SWM Programme.

The Yupukari turtle conservation project focuses on *ex situ* conservation, which involves the removal of turtles from their natural environment. Further, each year at the beginning of the annual

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Careful collection of turtle eggs from as water levels rise

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Preparing a river turtle for consumption

nesting season (late December to early February), monitors from CHI visit sand beaches near Yupukari village along the Rupununi River to retrieve yellow-spotted river turtle nests, which they bring back to the village. These nests are then placed in a hatchery and incubated for their remaining hatching time, for a total of approximately 75 days. Over the last ten years, CHI has refined the head-starting methodology to the point where hatching survival is similar to natural rates in the wild (85.2 percent).

Once the nests hatch, CHI keeps the turtles for one to two years before releasing them back to the natural environment during an annual turtle festival in the village, usually held in April each year. The festival brings together residents from across the Rupununi, and serves as an opportunity to raise awareness of the project and educate participants on the importance of preserving the yellow-spotted river turtle population.

Turtle management in Sand Creek, South Rupununi

For the past few decades, the residents of Sand Creek village have been concerned about the decline in their turtle population, which they attribute to various factors such as the annual Christmas feast where turtle meat holds a customary spot on the menu, erratic river water levels and the pet trade. In response to this, Sand Creek village requested support from SRCS as early as 2005; but, due to a lack of funding, a long-term project could not be implemented at that time. However, in 2021, SRCS received support from the SWM Programme, allowing it to provide Sand Creek with the requested assistance.

SRCS adopted an *in situ* conservation approach, which involves protecting nests and turtles in their natural habitat without dislocating them. This is achieved by protecting the nesting beaches and banning harvesting in the protected areas. To implement this method, SRCS began by holding consultations with the residents of Sand Creek village to determine the number and location of beaches that could be protected from human disturbance. Following this, SRCS trained a total of 14 rangers (five males and nine females) in the techniques required to monitor the nests, including conflict resolution, data collection and GPS use. The rangers monitored 12 beaches during the nesting season, recording the location of

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Yellow-spotted river turtle cooking inside its shell over the fire

new nests, preventing human disturbances, and relocating nests that were at risk of flooding or that had been affected by predators such as the gold tegu lizard (*Tupinambis teguixin*).

However, early unseasonal rainfall in 2021 and 2022 caused the Rupununi River to flood before the end of the nesting season. Because of this, SRCS rangers had to rescue as many of the accessible nests as possible and relocate them to Sand Creek village. Similar to the project in Yupukari, the nests were then artificially incubated, and the hatched turtles were released during consecutive turtle festivals in Sand Creek village. Due to the focus of the project being on *in situ* conservation, the Sand Creek project had not prepared for *ex situ* activities. The Sand Creek rangers therefore transferred the eggs from their original beaches to makeshift nests in their own homes. Despite this, the hatching success rates in Sand Creek were similar to those in the wild, as seen in Yupukari. As a result of this experience, in February 2023, SRCS and Sand Creek village built a hatchery similar to that found in Yupukari to further improve hatching success in case of flooding in future years necessitating nest relocation.

Towards a regional turtle management plan

The creation of a regional turtle management plan began in 2022, in a kind of domino effect following the successful models initiated in Yupukari and Sand Creek. Since 2021, and on a yearly basis, Yupukari and Sand Creek rangers have monitored more than 18 beaches along the Rupununi River and have rescued more than 3 000 turtle eggs from the wild. These conservation efforts have generated very positive buy-in from local community members, and have shown that communities have the capacity and dedication to conserve their local turtle population. As children and adults have become more involved through environmental education initiatives, neighbouring communities have also shown increased interest in receiving support to implement similar conservation activities. Within this context, the Rupununi river turtle management plan was perceived as an ideal opportunity to not only preserve the local turtle population, but also to collect the necessary information to sustainably use this resource sustainably in the future.

The regional management plan was designed using an inclusive and transparent approach that

©FAO/Luke McKenna
SRCS turtle rangers care for yellow-spotted river turtles after unexpected flooding and a successful rescue operation

ensured the primary stakeholders – the Indigenous and local communities – were involved from the beginning, and thus developed a sense of ownership of the plan. In September 2022, a road map for the development of the regional management plan was collectively proposed by CHI, SRCS, the SWM Programme, the North Rupununi District Development Board (NRDDB), the South Rupununi District Council (SRDC), Conservation International Guyana and the village councils of Yupukari, Rewa and Sand Creek. Based on the agreed road map, the regional turtle management plan was developed between October 2022 and March 2023 through a transparent and inclusive consultation process that included: one general meeting with village leaders from South and North Rupununi, 26 community-based meetings, a meeting with relevant regional and national stakeholders, including government institutions and NGOs, and a series of validation workshops. Throughout the consultation process, a concerted effort was made to ensure gender balance and inclusiveness of all community members, including fishers, hunters, village leaders and youth.

The regional turtle management plan is a vital step towards preserving the rich biodiversity of the Rupununi region, and ensuring the sustainable use and trade of its natural resources. The plan seeks to address the threats currently faced by the six species of freshwater turtles in the region: the yellow-spotted river turtle *(Podocnemis unifilis*), the giant amazon river turtle (*Podocnemis expansa*), the painted wood turtle (*Rhinoclemmys punctularia*), the mata mata (*Chelus fimbriata*), the twist-necked turtle (*Platemys platycephala*) and the toadhead turtle (*Mesoclemmys gibba*). Of these species, four are listed as being of least concern by the International Union for Conservation of Nature (IUCN) on its Red List of Endangered Species; while the yellow-spotted river turtle is classified as 'vulnerable' and the giant amazon river turtle as 'endangered'. Similarly, the yellow-spotted river turtle, the giant amazon river turtle and the mata mata are listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) , which lists species that are not necessarily now threatened with extinction but may become so unless trade is closely controlled, whilst the other three species are not listed.

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SWM Programme country coordinator, Oswin David, delivers a presentation to the Toshaos of Region 9

The plan aims to identify management interventions that the 26 participating communities wish to implement. The interventions in the management plan include:

- *in situ* nest monitoring;
- environmental education and behavioural change;
- nest relocation and head-starting;
- turtle farming for pet trade and meat consumption
- research; and
- development of village-level rules for the sustainable use of river turtles.

Village-level activities and annual work plans will be defined by each village in 2023–2024, with the technical support of SRCS, CHI and the SWM Programme. Further, the regional management plan emphasizes that nest relocation and head-starting should only be conducted as a last resort in response to flooding that would result in 100 percent mortality. As such, the plan promotes guidelines recommended by IUCN, including conducting relocation only when necessary, interfering with the natural cycle as little as possible, and ensuring reintroduction occurs close to the original habitat (IUCN, 2013).

Conclusion and recommendations

The creation of a Rupununi turtle management plan presents the opportunity for communities to concurrently implement activities that could ultimately reverse the population decline of river turtle populations in the region. The justification for the plan has been supported by the initial success es of current turtle conservation initiatives in the region, the desire from neighbouring communities to replicate these, and the calls from the international level to implement such plans (Norris *et al*., 2020). An inclusive and participatory approach was used to create the plan and it is essential that this continues during its implementation. Over time, the plan, will aim to cover more of the Rupununi, beyond the titled land of the 26 communities, and to advance efforts for the effective co-management of freshwater turtles in Guyana.

References

IUCN/SSC. 2013. Guidelines for Reintroductions and Other Conservation Translocations. Version 1.0. Gland, Switzerland: IUCN Species Survival Commission.

Norris, D., Michalski, F. & Gibbs, J.P. 2020. Community based actions save yellow-spotted river turtle (*Podocnemis unifilis*) eggs and hatchlings flooded by rapid river level rises. *PeerJ*, *8*, p.e9921.

Pierre, M.A., Jacobsen, K.S., Hallett, M.T., Harris, A.E.M., Melville, A., Barnabus, H. & Sillero-Zubiri, C. 2022. Drivers of human-black caiman (*Melanosuchus niger*) conflict in Indigenous communities in the north Rupununi wetlands, southwestern Guyana. *Conservation Science and Practice*, p.e12848.

Rosenblatt, A.E., Lardizabal, K., Li, F., Holland, A., Lawrence, D. & Taylor, P. 2021. Tourism value of crocodilians: the black caiman (*Melanosuchus niger*) as a case study. *Herpetologica*, *77*(4): 289–293.

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Ranger, Richard Peters, completes detailed surveys of giant anteaters on horseback

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